NSTA RGO Evaluation
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Table of Contents

Workspace Documents

See http://rgotfs.pbworks.com for documents and detailed information cited throughout this report (you must be registered to view this site)

I. Overview and Purpose

The purpose of this evaluation of the RGO program for K-12 teachers is to determine effective practices and obstacles to recruitment, support, implementation, follow up and evaluation with the resources available. Is it achieving what we want? Does the benefit merit the cost? In Education Flight Projects, RGO is listed as a student project. Teachers need to report in their 120-day follow up that they used this with their students. This report addresses the core question – how does RGO need to be designed to be get the teachers involved who will use it powerfully with their students and their schools over time?

Timeframe of the Evaluation
From May to September 30, 2010

As a part of this report, full documents and details have been cataloged on in a private web-based workspace at http://rgotfs.pbworks.com

II. Method

The evaluation will be conducted using a mixed methods approach.

- Existing NES survey data will be located and analyzed.
- Interviews with a random sample of participants (NASA Explorer School teachers, NEAT RGO teachers, NSTA teachers-2010) will also be conducted to better understand their motivations for participating, how they integrated the work into their curriculum, their perceptions of the effect on students and what they would say to other teachers considering this opportunity.
- NASA staff involved with the program will also be interviewed for their perceptions of the program structure, participants and for suggestions.
- NSTA staff managing the 2010 program will be interviewed about the promotion, application, and support structures.
- RGO staff will be interviewed about the their perceptions of the participants and program and suggestions for the future.
- The selection panel for the 2010 cohort of past NSTA presidents will be surveyed and a few interviewed for their perceptions of the application and review process.
- A representative of Zero-G will be interviewed about how they promote and operate their program. Teachers who participate in that model will also be interviewed (2-3) about the effects of participation.

Sample questions to be addressed in the evaluation study

Target population for RGO	*Which K-12 teachers can most benefit from this experience?* *What are their characteristics that make them interested and successful?* *What are the benefits to the teachers who participate from their perspective and from the staff's perspective?* *What are the barriers to their participation? (timeline, funding for travel, timeframe -summer vs. school year, other) How do they overcome them?* *What can we learn from other programs such as downlinks?*
Promotion	*How has the program been promoted in the past?* *How can the program be promoted to them without eliciting too many applications that will result in a low percentage of acceptances?* *What is the target number of applications per flight week opportunity? (5 to 1 ratio for 9-10 teams?) What is the best way to target the teachers who will make the most of it?* *How is the website structured? What information does it provide? How often is it accessed? Where is it linked from and to? Do teachers find out about the program from the website?* *http://microgravityuniversity.jsc.nasa.gov/* *How can it be improved to get a larger pool of applicants?*
Application process	*How can the application process be used to get the right people to apply? With adequate rigor and follow through? In others words, how can the application process be rigorous enough to require an investment by the applicant, and yet be doable by the teachers who are most likely to benefit from it?* *Would a more rigorous application be a deterrent? (NSTA application is watered down undergraduate version)* *Is what they are proposing beneficial to the schools? Become part of classroom lessons or change how they teach?* *What is a reasonable timeline for teachers from when they hear about it to when they apply, to when they fly, to when they complete the follow up?* *Are canned experiments the way to go? (like the Zero-G flights?)*
Selection process	*How are applications reviewed and accepted?* *Does the selection process result in the projects that are worthy and teachers that follow through?* *What are the characteristics of teachers and their applications who do not participate, drop out, or fail to complete elements of the experience?*
Support prior to flight	*What kind of support do teachers need prior to flight week to be prepared?* *How has the NSTA webinar approach been working for the teachers and staff? Is it effective? Doable? Motivating? Learning from them? Take too much time?* *How does NES support teachers ahead of time?*
Flight week	*How closely aligned are teacher expectations and the actual experience?* *Did teachers achieve their objectives? Science? Personal? Were they able to engage their students with it?* *How does each of the activities contribute to the goals for the teachers?* *Were there any missing pieces? Something they would have liked to*

	occur? Speak with more engineers? Scientists? Prep time, more or less? Some groups are ready to go, others have to scramble to get ready.
Follow up support after flight week	*What do teachers do with students and their schools after the flight week? What support do they need, or would appreciate for those activities? Webinars with NSTA participation? Value? NES follow up? Who do they share the experience with?*
Evaluation	*What are the effects on the teachers, their schools and their students? How are the effects currently evaluated and reported? How do we ensure cooperation in evaluation from the participants?*

Data Collection Sources

Surveys	N=119
45	NES RGO teachers 2009-10
40	TFS NSTA team members 2010
7	NEAT RGO
27	NEAT teachers
Interviews	N=46
9	NES and NEAT teachers
1	NES professional development coordinator
15	TFS NSTA applicants, drops, finishers
3	NSTA staff
3	NSTA selection panelists
2	Zero-G staff and participants
4	RGO staff
15	**NSTA 2010 RGO** teachers
3	NSTA staff
10	NSTA review panel
Ad hoc analysis	N=230
230	NES end of experience surveys form 2004-2010
Analysis of documents	
3	Websites, NES, Undergraduate, SEED
3	Annual reports 2008, 2009, 2010
Observation	
Flight week	Activities related to experiments, professional development
Webinars NSTA	March 4, May 10, May 17, May 20, July 8

Data Analysis

Interview and survey data will be summarized and analyzed for themes across stakeholders with particular attention to how to get teachers involved who will greatly benefit from this unique experience. Discourse analysis techniques (Johnstone, 2002, and Schiffrin et al, 2002)[1] will be used to analyze qualitative data. Likert type question data will be analyzed for mean, median, mode and frequency by item.

[1] Johnstone, B. (2002). *Discourse Analysis*. Oxford: Blackwell.
Schiffrin, D. Tannen, D. & Hamilton, H. E. (eds.). (2001). *Handbook of Discourse Analysis*. Oxford: Blackwell.

III. Findings

As presented in the methodology section, we made very attempt to get the ideas and opinions of NES teachers who have participated, NEAT teachers who have not participated, RGO staff, NSTA staff and past presidents who reviewed the applications, and EFP/TFS staff. We analyzed the undergraduate programs (design and systems versions) because they have a long history of success and the pre-college experiences were based on the undergraduate model. We also analyzed the private experience (Zero-G Corporation) for ideas on how to structure the program. In all our interviews we asked people for their ideas on how to make this worthwhile for them and others. We observed the TFS NSTA flight week to better understand the nature, purpose and benefits of the experience. In this section, we discuss each program area based on the data we collected. In the next section, we discuss how what we learned can be applied to the future of RGO as sponsored by the Teaching from Space office.

A. Target population for RGO

A fundamental question for this project is to identify the teachers who can best take advantage of this unique and high cost experience to enhance their students' knowledge, understanding and enthusiasm for STEM content and careers, their own understanding of the science research process, and their school's and colleagues enthusiasm for NASA and STEM. Questions guiding our evaluation included the following:

- Which K-12 teachers can most benefit from this experience?
- What are their characteristics that make them interested and successful?
- What are the benefits to the teachers and students who participate?

Goals and Objectives
Clear goals and objectives are integral to identifying the target population. We can use both an inductive and a deductive reasoning approach to clarify this area. In the inductive approach, we look at past projects to see who benefitted from the program and in what ways, and based on that derive goals and objectives. Deductively we can identify the goals and objectives the experience could support, and identify the target populations that would benefit.

A goal is defined by Miriam-Webster dictionary as, "the end toward which effort is directed." An objective is defined as, "involving or deriving from sense perception or experience with actual objects, conditions, or phenomena." In other words, goals are what it is hoped will be achieved; objectives are the measurable components needed to achieve that end. For example:

Goal: Knows about the bones in the human body.
Objectives:

- Will be able to name all of the bones in the human body as stated in the medical textbook "The Human Body."

- Will be able to point out where the bones are in the body and describe their function(s) in that location.
- Will be able to accurately describe the structure and function of the skeletal system in relationship to the other systems in the body.

Inductive Approach

Which K-12 teachers can most benefit from this experience? What are their characteristics that make them interested and successful? Who can benefit from the RGO project? The answer to this question from all the groups surveyed and interviewed focused on individuals that have a lot of drive to involve students in meaningful research-based experiences. These teachers are highly motivated to integrate this experience into their curriculum and into the life of their schools. They are adventurous with their curriculum and in their outlook on life. They recognize that RGO is an unusual opportunity that requires creativity, and great attention to detail, as well as the ability to seek out and use input from others on their team, their mentor, and other experts to improve the research. As the teachers put it,

> *They recognize what their district and NASA are contributing so that they might be able to perform real research so they take this experience back to their district and peers to enhance their programs overall.*
>
> *The ideal candidate is a leader or mentor to his/her peers and looks to improve the science and math programs of their school or district and not merely their own classroom.*

Everyone, especially those teachers who have done RGO, emphasize the need for energetic teachers who are willing to work hard, put in long hours with their students designing and testing their experiment, and pay close attention to detailed NASA guidelines every step of the way, e.g.

> *They must be organized and come with a plan. However, they must recognize that their plan will mostly likely change*
>
> *Hard working and organized person able to follow commands from NASA*
>
> *Naturally curious, patient, good listener and flexible, appreciates teamwork*

Grade level and content expertise seem to be less important than a willingness to learn and make a strong connection to the curriculum and the school goals, e.g. *Knowledgeable yet wanting to know more.* Elementary teachers make the case that they can get students excited early so they pursue STEM careers. Middle school teachers point out that have more flexible curriculum, and high school teachers teach many sophisticated concepts that can be *made real* through experiments in microgravity.

> *Adventurous with their curriculum, the type of teacher that isn't stuck in a rigid curriculum plan*

All grade levels benefit provided the teachers have sufficient background

The teachers need to be committed to NASA and its goals, and have the time and flexibility in their curriculum to include the preparation and testing with students, or do it as an after school program.

For students to get the most out of the RGO experience, the teacher needs to be someone who supports student inquiry. They may be into problem-based learning, competitions, or design challenges. Teachers put it this way:

A real listener, relates to kids, able to get them involved in problem solving

A teacher researcher familiar with problem-based learning

One who cares about students and subject matter. This really is about them so they need to be involved in all aspects of preparation and the design process

Is used to working with student teams on projects

We also asked teachers who had participated, **"What are the benefits to the teachers and students who participate?"** All the teachers who have participated would do it again and recommend it to others because of its value as a research experience.

This is inquiry at its best! Real science, real data, real world!

Teachers are involved first-hand in the scientific process, and their students experience this along with them. The parameters of the variables are so specific and narrow, that it makes it very complex.

The kids used technology and a Wiki space I created to follow daily events -they understood why a hypotheses was important and could see and participate in the scientific method as we went through the process.

They describe the excitement students have when they realize they are designing an experiment with NASA.

It was a real life experience for our elementary students. The excitement caught like a fever- throughout the elementary schools and to the parents and community. It brought everyone together and everyone was involved. It was the chance of a lifetime, better than meeting Mickey Mouse!

This was an invaluable experience for me and my students! The science that we delved into was fascinating and engaging.

Teachers develop a much better understanding of NASA, a greater appreciation of the space program, and get excited about being involved with NASA on a project.

For teachers, the research experience may be their first so they feel it enhances their ability to teach the scientific process.

> *Many teachers do not have research experience so they get to experience what they teach.*
>
> *Teachers need to coordinate many things in order to be successful. Teachers and students get to learn more about the work of NASA and STEM careers, and also about forces and motion.*

The complexity of the process engages everyone is detailed and collaborative work that is not only engaging but also "fascinating" as one teacher put it.

> *Combining ideas to put more rigor into our classes. Cross-curricular connections.*
>
> This is a practical application of theory. Kids see what's going on outside classroom

From an **inductive perspective**, the teachers who teachers who feel they are successful and benefit are knowledgeable about NASA and committed to engaging students in an authentic design, build, and test research experience. From the **inductive analysis**, the goals and objectives of the program could read:

Goals:

- Teachers use RGO to engage students, faculty and community to motivate them to learn more about NASA STEM topics, processes and careers.
- Students learn how to do research by participating in a reduced gravity design, build, data collection and analysis, and sharing of results for a reduced gravity experiment.

Objectives

- Teachers will teach students about NASA, microgravity, experimental methods and prior RGO experiments to facilitate student development of a proposal for a RGO experiment.
- Teachers will facilitate student building and testing of an apparatus for the experiment and ground tests of it in 1g for students to collect data, refine their hypotheses, and improve the apparatus.
- Teachers will work with a NASA mentor throughout the process, connecting the mentor with the students to improve the experiment.
- Teachers, with support from the NASA mentor, will conduct the experiment and collect data in micro and hyper gravity, and share the results with students.
- Teachers will facilitate student analysis of the data, drawing conclusions and sharing the results with wider audiences.
- Teachers will provide access and information about further NASA STEM resources and opportunities to students, faculty and community.

Deductive Approach
For the deductive approach, we examine the goals, objectives and/or descriptions and requirements of the TFS, NSTA TFS, Undergraduate and SEED RGO programs to understand the potential target populations for each.

The goals and objectives stated on the NES RGO website[2] are:

Goals

- Provide educators and student the opportunity to experience developing an investigation just like scientists and engineers.
- Provide the students and teachers the opportunity to test their investigation in a reduced gravity environment.

Objectives

- To provide students the opportunity to design, fabricate and evaluate an investigation to be tested in reduced gravity environment.
- Provide the opportunity for educators to experience reduced gravity.

The TFS NSTA RGO announcement described the program:

> NASA reduced gravity flight experiences offer educators the opportunity to successfully propose, design, and fabricate a reduced gravity investigation of their choice with their students; fly the experiment; conduct research in a microgravity environment; and evaluate the investigation. Educators then share their findings with their students (who are not permitted to fly) and emulate the nature of inquiry to the larger education arena via a community experience of learning and future flight participants. The opportunity offers educators the opportunity to participate in first class immersive inquiry learning experiences and to engage, educate, and inspire their students in the STEM disciplines using NASA unique content and resources.

The application requires a description of the experiment, student hypotheses, correlation to the classroom curricula, community and media outreach effort, community and family involvement, professional development/research dissemination, letter of commitment from the school administrator, and an optional 1-2 minute video. Teachers agree to participate in pre and post flight web seminars and activities. From this information, additional information from RGO staff and observations and interviews, the goals and objectives could read:

Goals

- Students and teachers experience an immersive inquiry learning experience using NASA unique content and resources
- Teachers are prepared to support students in doing inquiry
- Students and teachers share their inquiry experience with their school, families and community

[2] http://microgravityuniversity.jsc.nasa.gov/nes

Objectives

- Teachers will facilitate students doing inquiry in the microgravity environment with the support of a NASA mentor
- Students will design and fabricate a reduced gravity experiment, communicate with teachers who fly the experiment and evaluate the investigation
- Teachers and administrators will facilitate sharing the investigation experience and results with the community

The undergraduate design website implies a similar set of goals and objectives for students in the description under the "About the Program."[3] These teams are also required to have a faculty member but they are able to conduct the experiment in micro and hyper gravity themselves.

> The Reduced Gravity Student Flight Opportunities Program provides a unique academic experience for undergraduate students to successfully propose, design, fabricate, fly and evaluate a reduced gravity experiment of their choice over the course of four-six months. The overall experience includes scientific research, hands-on experimental design, test operations and educational/public outreach activities.

Given this description and other information on the website, the goals and objectives for this program could read:

Goals

- Undergraduate students learn how to do scientific research, hands-on experimental design, test operations, and educational/public outreach activities
- Undergraduates have a motivating STEM career-related experience.
- Undergraduate faculty use RGO as a motivator for engaging students in NASA STEM career studies.

Objectives

- The undergraduate RGO team will successfully propose, design, fabricate, fly and evaluate a reduced gravity experiment of their choice over the course of four-six months
- The undergraduate RGO team will do outreach to other students, faculty and the community based on their experiment.
- The undergraduate RGO team will prepare a report on their RGO experiment.
- The undergraduate professor (RGO team advisor) will facilitate the student team in the process; providing information, guidance, reviews and ensuring adherence to NASA guidelines.
- The undergraduate professor (RGO team advisor) and RGO team will support subsequent year's teams from their institution by sharing information, lessons learned, apparatus and results.

[3] http://microgravityuniversity.jsc.nasa.gov/

The undergraduate SEED website provides this description[4] for the Systems Engineering Educational Discovery program using the RGO.

> This project offers a nationwide solicitation of student application aimed at addressing systems engineering challenges within a microgravity environment. NASA has identified ongoing projects that are systems engineering and reduced gravity related.
>
> The overall experience includes scientific research, hands-on investigational design, test operations and educational/public outreach activities. SE investigations will adhere to the same processes and procedures governing NASA research and test flights so that SE students and faculty gain insight into the workings of NASA and ensure participant and investigation safety guidelines are followed.
>
> The students attached to the selected proposals would then work with a NASA principal investigator lead for that project, to prepare the experiment for flight. In addition to student involvement, one university/college faculty member will be invited to fly with each team. This will help to provide faculty members with teaching materials in their classroom and can be used as a motivator to increase their students' interest in systems engineering.
>
> In addition to the student-based research, they will participate in a number of Digital Learning Network events (videoconferences). Incorporated as part of the NASA experience, and working in conjunction with other NASA and engineering organizations, student teams will participate in up to three videoconferences as part of a systems engineering design challenge through the Digital Learning Network (DLN).
>
> Conditions permitting, each investigation will be flown twice so that there can be replication of the investigation and any problems encountered during the first flight can be corrected during the second.
>
> After returning to their respective campuses, flight team members conduct technical outreach events for younger students. As part of the experience, teams will be assigned mentors with specialties in systems engineering.

This program is clearly focused on systems engineering with students working with NASA principal investigators on something NASA needs. Students are expected to mentor younger university students in systems engineering (one student team member must be a senior). This program’s goals and objectives are somewhat different than the undergraduate design RGO experience. They might include:

[4] http://microgravityuniversity.jsc.nasa.gov/se

Goals

- Students address NASA systems engineering challenges within a microgravity environment
- Students and faculty gain insights into the workings of NASA by working with a principal investigator to design an experiment to be conducted in microgravity that will provide data about a NASA identified need.
- Undergraduate faculty experience conducting an experiment in micro and hyper gravity to use in their teaching to increase student interest in systems engineering

Objectives

- Students work with a NASA principal investigator lead to prepare the experiment for flight, then analyze results and draw conclusions
- Students will learn from mentors and experts using videoconferencing
- Undergraduate student teams will conduct technical outreach events for younger students at their institutions and act as mentors in systems engineering
- The undergraduate professor (RGO team advisor) will facilitate the student team in the process; providing information, guidance, reviews and systems engineering expertise
- The undergraduate professor (RGO team advisor) will use their RGO experience in their teaching

Summary for Target Population Findings

Goals and objectives were defined for each program based on inductive and deductive reasoning approaches. These goals and objectives define the target population as those who can successfully accomplish the objectives. Based on the goals and objectives, the application, requirements, and support for each program can also be defined. These clear expectations will attract applications from teachers who feel they can meet them and also help define the portfolio of opportunities available to teachers to use with their students year after year, and the pipeline of NASA opportunities for students during their academic years.

Teaching from Space and Education Flight Projects are based on the hypothesis that:

> "… teachers and students can benefit from experience with flight-related projects going on at NASA. Offering unique, NASA-only, experience can excite, inspire and engage teachers to incorporate NASA resources into their curricula and students to develop, pursue and sustain an interest in STEM topics and careers." (2009 Evaluation Report, p. 4).

The outcome objectives are: (2009 Evaluation Report, p. 7).

1. Teachers learn NASA related STEM content
2. Teachers connect NASA content to STEM literacy
3. Teachers and students conduct investigations with NASA resources
4. Students experience using tools for investigation
5. Students reflect on their NASA experience

RGO supports the TFS goals and objectives in that teachers use NASA resources to prepare students to develop a proposal for a microgravity experience, learn about the investigation process in NASA, and support their students in conducting investigations using tools and NASA resources (including the mentor) and analyzing the data from the experiment in micro and hyper gravity. Students then reflect on their NASA experience through their reports and presentations in their communities. If we refine the goals and objectives created from the current description of the program (deductive approach) with the insights gained from the interviews and surveys (inductive approach) and in light of the TFS/EFP goals and objectives, they can be more focused for elementary, middle and high school audiences leading up to participation in the undergraduate program. We will expand on this idea of a developmental approach to RGO after reviewing the components of the current experiences and formulating objectives for each level in the future. For elementary, the goals are focused on building interest and enthusiasm for research and NASA STEM. Middle school teachers report that the experience is very motivational for their students and that they can also use it to teach research skills and content. High school teachers use RGO for building interest, teaching curriculum concepts in an authentic context, and for a career experience. Goals for each level could read:

Elementary Goals

- Teachers use RGO to engage students, faculty and the community to motivate them to learn more about NASA STEM topics, processes and careers.
- Students learn what it is like to be a researcher by participating in a reduced gravity experiment.

Middle School Goals

- Teachers use RGO to enhance their curriculum by engaging students in a microgravity experiment.
- Students are motivated to learn more about NASA STEM topics, processes and careers related to gravity.
- Teachers and students share their experience with their school and community to motivate to others to learn more about NASA and STEM.

High School Goals

- Students and teachers experience an immersive inquiry learning experience using NASA unique content and resources about gravity
- Teachers are prepared with knowledge and NASA resources to support students in doing inquiry about gravity through designing and conducting an experiment in hyper and microgravity
- Students and teachers share their inquiry experience and results with their school, families and community to motivate to others to learn more about NASA and STEM.

B. Promotion

In this section we look at the ways the various RGO programs have been promoted, and what we can learn from other programs. We also asked teachers how they found out about it.

Questions that guided our investigation included:

- How has the program been promoted in the past?
- How can the program be promoted without eliciting too many applications that will result in a low percentage of acceptances?
- What is the target number of applications per flight week opportunity? (5 to 1 ratio for 9-10 teams?) What is the best way to target the teachers who will make the most of it?
- How is the website structured? What information does it provide? How often is it accessed? Where is it linked from, and to? Do teachers find out about the program from the website? http://microgravityuniversity.jsc.nasa.gov/

TFS NSTA 2010 Promotion

NSTA was contracted to do only limited promotion of TFS RGO pilot opportunity through NSTA internal networks. The first calls for applications were distributed through the 18 district directors at the beginning of February 2010 (See Appendix A for copies of the emails). Additional emails were sent to 300 or more people/groups on their Chapters and Affiliated Groups (CAGs) lists with requests for distribution through their various networks. In addition, NSTA selected certain schools (approximately 50 with multiple teachers from each school on the distribution list) with a potential interest or existing programs in aerospace education and sent another wave of emails to that target group. A notice was also distributed through the NSTA Science Matters network. This resulted in about 50 inquiries. The feedback NSTA received was that it was difficult to keep team members involved when they found out they would be paying expenses for the 10-day Houston trip.

The teachers who were selected reported the following sources:

Number of times	Source
10	Colleague
10	NSTA email
5	DuPont (sponsor of Delaware teams)
2	Forwarded email (from outside source)
2	NSTA affiliate
2	STEM conference
2	My team leader
1	Regional in-service, NEAT, Florida Space Report, T-STEAM program, twitter, science specialist from my school district, NASA staff member

Most of the teachers found out from a fellow teacher or from an email from NSTA. Many of the teachers only received the last email that went to all the membership in March so they had to move quickly to put a team together and submit an application.

It was expected that the personal invitations from NSTA board of directors and council members would result in a good number of quality applications. NSTA chapters and associated groups such as state science teacher associations were approached. In the undergraduate program, RGO expects at least 70 applications for 14 team slots. When the networking approach did not result in many applications, NSTA advertised to broader and broader audiences.

The promotion timeline was also a factor and will be discussed in more detail in its own section in the context of the whole timeline. Both NSTA and teaches would have liked to have had more time to promote the program to get the word out about the opportunity. NSTA is publicizing this year's program through its website. Teams will be presenting their research through a series of NSTA webinars in December 2010 that will be open to the entire membership.

One of the concerns raised by the Teaching from Space staff was having too many applications, causing disappointment for a large number of people. When we asked teachers about it, almost all of them said they were used to competitions being difficult.

> *I told my students we were going to learn about microgravity and think about what we would like to know about it, and that we might get to do our experiment, and we might not, but either way we would learn a lot.*

> *I think as long as it is clearly laid out how many spots there are and there is a clear, fair process for selecting teams, it is not a problem to have a lot of competition for a few slots. You know what you are getting into to.*

> *I think this is such an amazing unusual opportunity; it should be hard to get in.*

One person we interviewed described another STEM program on nanotechnology that she saw as similar to RGO in that it is a narrow, sophisticated topic that requires creative, flexible teachers to integrate it into their curricula. The nanotechnology program also has a large time commitment; three years teachers including summer workshops and implementation in their classrooms during the academic year. It was advertised to state science supervisors and all 300,000+ members of NSTA nationally. As a result, 110 applications for 20 slots were received.

TFS RFO NSTA Past President reviewers also commented on the number of applications, the application timeline and how to limit the number of applications by having very clearly defined expectations:

> *There clearly were not enough applications. From discussion I had with some folks who applied and those who decided not to apply, the time frame was simply too short. More advance notice is needed. To be able to develop a project of this caliber the applicants need more time to be able to collaborate.*

Certainly if more applications are received the number of quality applications will increase and the percentage of success will be less, but I don't see that as a deterrent.

The key thing is to be clear what are you looking for in the applicants. If it is broad-based, not narrowly enough defined, you will get too many. If it is fits in high school physical science courses (chem., physics, engineering, math, technology courses), don't be afraid to say so.

Some of the teachers said they knew about RGO and were always keeping an eye out for when applications might open up, and they still heard about this one at the last minute and only because of the NSTA email. When we asked teachers how to effectively promote the program, they offered the following suggestions:

- *Email, listservs, NASA e-blasts (to local teacher association representatives, department heads, science teachers, content supervisors, principals)*
- *Web - the ones seeking out new opportunities will find it. Make sure there is a website that comes up at the top of the search list. Put all the information about applying on the website. Have applications open up at the same time every year so we can plan.*
- *Through professional organizations such as AAPT, NABT, NCTM, ASA, NSTA, National FFA, NEST, NAAE, NEST*
- *Presentations and booths at STEM teacher conferences or teacher workshops, regional and national*
- *Have teachers who have done it "tell everyone"*
- *Regional in-service centers*

Past NSTA presidents suggested promoting the program through NSTA publications, such as Science Scope, The Science Teacher and NSTA Reports and the Journal of Physics Teachers Association. Part of team's follow up might be to contribute to an article about the program.

This is pretty specific to a small group of interested teachers at the high school level so I would say focus the contact list on those who are most appropriate and able to use this. For example, biophysics would work, but not general biology. Physics teachers or pre-engineering teachers could use it in their classes.

NES Promotion

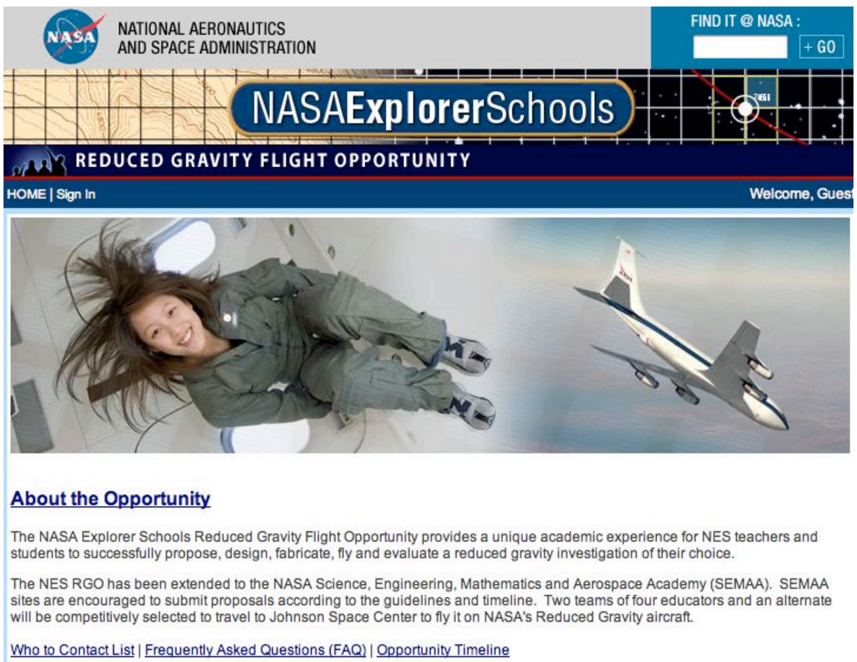
Because NASA Explorer Schools have an ongoing relationship with NASA, the leadership team in the school receives weekly "eblasts" on upcoming opportunities. RGO was one of several "special opportunities" they could apply to in their second year of participation beginning in 2004. The program began in 2003 with 50 schools and grew to 250 schools at its peak in 2006. While the number of applications for available slots has not been recorded over the years, the staff reports it is generally 50% more than the available slots. So for 10 team slots, they might get 16 applications. Some schools have applied and been successful in participating more than once. New schools are encouraged to apply and given preference over returning teams. All expenses are paid for travel to Houston. Teams must pay for their own materials and expenses associated with building their experimental apparatus. Participation in NES has varied over the years depending on funding more than interest.

Year	2004	2005	2006	2007	2008	2009	2010
# Teachers	17	*	30	70	48	40	45

*In 2005 the plane was not available to NES teachers

NES also has a website on its RGO professional development opportunity. A search on "reduced gravity opportunity" results in the NES website showing up at the top of the list followed by the undergraduate program website.

http://microgravityuniversity.jsc.nasa.gov/nes/



The experience of NES is instructive in that the barrier of cost of the Houston trip is removed, and it is part of a strong professional development program; two assets in recruiting teachers. Yet, they still do not have a large number of applicants. When asked, teachers report that the time commitment, intensity, sophisticated content, and being out of school for 10 days make it a program that only a few teachers are interested in or qualified to follow through with.

It is important to note that NSTA partners with NES through Oklahoma State University in implementing professional development. NSTA sends out the weekly eblasts prepared by NES, manages registration and travel, and tracks participation.

NEAT teachers reported that they would like to be involved in the program if they could. For example, several of them are no longer in the classroom, but they would be willing to work with a team. Others have flown before and are under the impression they are not allowed to participate again.

Undergraduate Program Promotion
As mentioned earlier, the undergraduate program generally receives at least four to five as many applications as there are slots. The program began in 1995 with four teams of college seniors from Texas' Rice and A&M Universities (called SURF Student Understanding Reduced Gravity Flight). It was renamed in 1996, the "Reduced Gravity Student Flight Opportunities Program (RGSFOP).

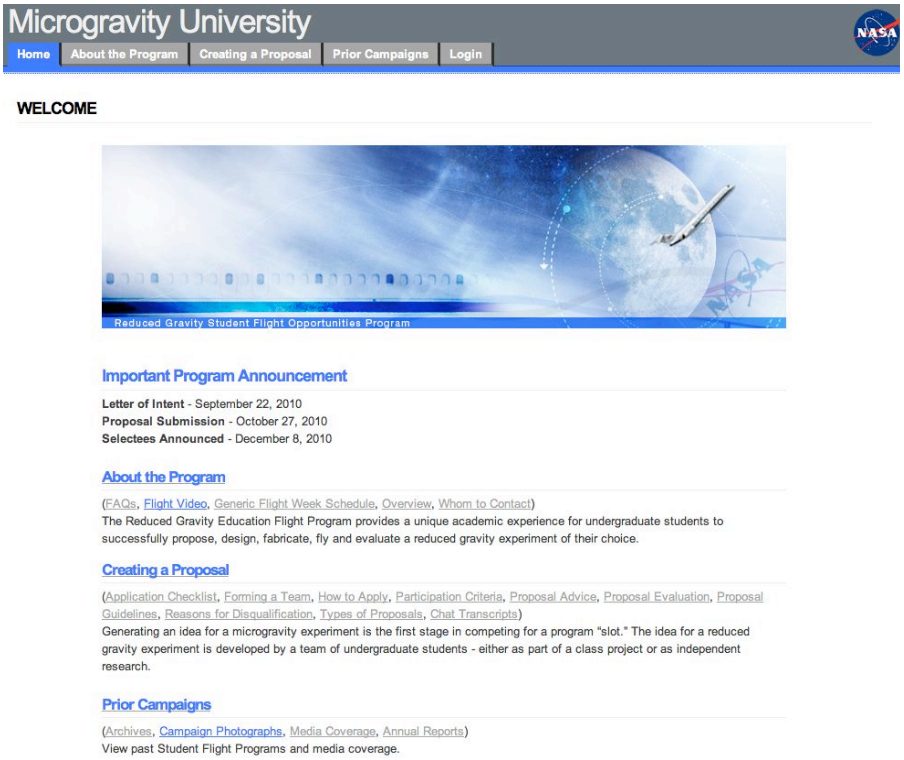
Year	Time of yr	# Teams	# States	# Institutions
1995	Summer	4	1	2 UG
1996	Summer	4	1	4 UG
1997	Spring	23	15	28 UG
1998	?	46	25	37 UG
1999	Spring & Summer	76	29	33 UG
2000*	Spring	47	25	38 UG
2001	Spring	82	37	63 UG
2002	Spring & Summer	50	28	43 UG
2003	Spring & Summer	68	31	54 UG
2004†	Spring & Summer	68, 3	28,3	44 UG, 3 NES
2005*	Spring	10	8	10 UG
2006†	Spring & Summer	60, 11, 7, 6	43, 8 6, 6	26 UG, 11 NES, 7 Informal 6 WYP
2007†	Spring & Summer	31, 20, 4	19, 17, 1	28 UG, 14 NES, 4 Special Opportunities
2008†	Spring & Summer	40, 14, 11, 10	23, 14, 9, 9	33 UG, 14 NES, 11 NEAT, 10 SEED
2009†	Spring & Summer	19, 10, 8, 13	17, 9, 6, 8	19 UG, 10 NES, 7 SEED, 13 Special Opportunities
2010†	Spring & Summer	14, 13, 13, 11, 2, 1	12, 11, 10, 8, 1, 1	13 UG, 12 SEED, 18 NES/SEMAA/MUST, 11 TFS NSTA, 2 DOE, 1 HUNCH

Based on 2009 Annual Report, Appendix B plus info from RGO office
* Teams were shifted into next flight campaign year due to aircraft maintenance and delays
† Numbers are in order of the program list in the institution column

Over time, a program develops a history with institutions that promote it, and have an oral history among the students. Many of the undergraduate institutions that participate have aerospace degree programs so they see this as a pipeline opportunity for their students. Their goals are aligned with the goals of RGO.

To promote the program, the website has information about how to apply and what the program involves.

Microgravity University – http://microgravityuniversity.jsc.nasa.gov/



In addition to the website, RGO does a mass mailing to universities with engineering and science departments, their deans and presidents. RGO has compiled a database of contacts at universities (over 3000 contacts). Past participants, USRP and other students who have expressed an interest also receive emails. Community colleges are also contacted.

Summary for Promotion Findings

The promotion of the RGO program needs to be both targeted and broad, and develop a legacy with K-12 as it has done with undergraduates.

NSTA's membership is a good place to start promoting RGO since science teachers are the primary participants to date. Most of the successful teams had a strong science person as the lead who had recruited other teachers to be members of the team. RGO actually recommends a physical science teacher since that is the strongest content connection. The RGO staff and the teachers who have participated in the past are both quick to point out, however, that any teacher can be successful who understands the content, is willing to work hard under the rigorous conditions required by NASA, and is enough of a leader in his or her own school to involve the school and community in the experience. From this year's pilot, it would seem that starting broad, and starting early would appear to be more effective than networking through smaller groups to find appropriate teachers.

Mailings to Principals and Directors of Curriculum can get early institutional support as we saw with several of the TFS NSTA teams. When the supervisor recruits the teachers, he/she wants them to be successful.

The risk of having too many applications seems to be minimal. None of the RGO programs have had that problem. Other sophisticated programs, such as the nanotechnology example given here, also do not seem to be overwhelmed with applications. The time and cost barriers may also mitigate the number of applications.

Having programs at different times of the year (January to December and August – June) may also increase the number of applications. Different teachers seem to prefer a spring or summer flight based on their curriculum and testing schedules, and their districts' policy about absences. Some districts now require teachers to pay their own substitutes when they are absent for opportunities like this. Other districts do not allow their teachers to be absent from school (other than sickness) during test preparation periods in the spring. Coaching schedules also eliminates travel for some teachers in different seasons.

Targeting teachers who do this kind of activity in their schools may be a good strategy. Who does other competitions? Who does NASA activities? These teachers have the interest and skill set to consider an involved project like RGO. Creating partnerships within and outside of NASA for co-advertising, or finding participant lists on the web could promote RGO. Listservs for science teachers, particularly physical science teachers, or for competitions for students are other potential avenues for promotion. Identifying where RGO fits in the NASA portfolio of activities would support promotion by feeder programs, and subsequent opportunities. Creating mentors for new teams could lead to teachers who have participated recruiting other teachers for the chance to participate again.

Creating buzz about the program will contribute to promotion. A website for TFS NSTA like the NES website will make the information easier to find. It could have new information all the time that even unsuccessful applicants would find useful and be able to use in their classrooms. Requiring participants to reach out to other teachers could create interest. Having local press involved (as in the undergraduate program where a journalist can go with the team) might create more interest. Some participants talk about having a huge contingent of people meeting them at the airport like they were rock stars. Others say they could not seem to interest the press. More support for how the participants can create buzz all along could help promote the program. NSTA articles and news stories about the program at each stage of the process will build awareness. Having a presence in social media such as Facebook builds a support base of teachers that other teachers can tap into if they are thinking of applying.

Making year after year opportunities available will promote institutional interest. Like the undergraduate program, institutions like programs they can do year after year. Maybe different opportunities at each grade level could be identified, leading to a team doing RGO. For example, students could do sounding rockets, or balloon sat, or DIME Dropping in a Microgravity Environment. Or different levels of the program could be offered. The lead teacher might participate over and over again but bring in new teachers for the team, and new students. The lead provides the accumulated knowledge that supports the team so more teachers and students are involved who might not attempt it on their own.

C. Application process

The application for TFS NSTA RGO was adapted to provide more scaffolding for teachers and students than the undergraduate program offers. One of the objectives for the undergraduates is to learn how to develop a full technical proposal. In the SEED program, they write an essay that shows their knowledge of systems engineering since the issue is defined by the NASA principal investigator (PI). Some of the questions we asked about the application were:

- How can the application process be used to get the right people to apply? With adequate rigor and follow through? In others words, how can the application process be rigorous enough to require an investment by the applicant, and yet be doable by the teachers who are most likely to benefit from it?
- Would a more rigorous application be a deterrent? (TFS NSTA application is scaffolded)
- Should previously conducted successful experiments or apparatus be offered to teams?

In this section we review the application forms and processes for TFS NSTA, NES, Undergraduates and SEED and consider them in terms of the goals and objectives of each program.

TFS NSTA Application

The application was part of the announcement sent out by NSTA so teachers received it as part of an email. The application form was not online on a website or in forms based tool. The application asked for the following information:

- Teacher team information
- The student experiment
- Student hypotheses and expected outcomes of the investigation in microgravity
- Correlation to classroom
- Community and media outreach effort
- Community and family involvement
- Professional development/research dissemination
- Letter of Commitment from the School Administrator
- Supplemental information - optional one-two minute video

For the full announcement and application see the workspace:
http://nasatfs.pbworks.com/RGO-Application

This version was developed to obtain the information RGO needs to evaluate the merit, safety and technical requirements of each proposal. They expect to see procedures and "down in the weeds" detail to evaluate its feasibility and merit.

The application also needs to demonstrate that the team understands the concept of microgravity, the test conditions on board, and experimental research. In the webinars and in interviews, the RGO staff emphasized that the investigations need to be experimental with controls and variables that require data to be collected in micro and hyper gravity to test a hypothesis about how something works, under what conditions and in what ways.

> *The experimental method is a systematic and scientific approach to research in which the researcher manipulates one or more variables, and controls and measures any change in other variables.* *http://www.experiment-resources.com/experimental-research.html*

Observational experiments are not appropriate; ones that ask the question, "What will happen?" do not meet the goals of the program. This requirement for using the experimental method is to ensure that the teams understand gravity and its affects, and are investigating a question that can be answered in the Zero-G plane flight protocol. It also supports the goal of students developing an understanding of how to do experimental research.

Sections 7 & 8 address the experiment:

Part 7: The Student Experiment.

- What is the title of your investigation?
- How did you and your students come up with this investigation?
- What scientific concepts are being tested?
- How is gravity as a variable relevant to this investigation?
- List the tasks/phases of the project to be completed by students (examples – investigation build, scientific research, planning trip to Houston, post-flight analyze, publish final report).
- Describe your testing procedure. What steps will you perform when the plane is in free fall? What steps will you perform when the plane is in hyper-gravity?
- What do you expect to happen?
- Is this investigation a free-float?
- Has your school or school district flown this investigation in a prior flight on a NASA Microgravity Aircraft?

Part 8: Student Hypotheses and Expected Outcomes of the Investigation in Microgravity.

Student Hypothesis/Outcome 1:
Student Hypothesis/Outcome 2:
Student Hypothesis/Outcome 3:

Teachers from the TFS NSTA group gave mixed reviews of the application. The biggest concern was the time of year and short notice.

> *Great, but short notice this year (heard about it on spring break, busy time of year)*
>
> *Easy to follow - good communication*
>
> *Long but important*
>
> *I think the application process was fine*
>
> *The process was much clearer and simpler when I did the program in 2007*

Concerns were about the redundancy of the some of the information required and the length.

> *Some of the application process was unclear and repetitive*
>
> *Too long and repetitive -very wordy. We need to read a sentence in the 15 seconds we have to check email and understand what we need to do. Use simple language.*
>
> *Make it clear and don't ask the same questions over and over. Have some of us alumni look it over and offer suggestions. Perhaps we could be included in the review process.*
>
> *Make the application simple, look for teachers who reach a wider audience, and get short administrator references*

The teachers' comments about redundancy may indicate a lack of understanding of the experimental method and what is required in each section. Since one of the goals of the program is to have teachers participate in a research experience to develop their understanding of it and incorporate into it their teaching, it may be necessary to better define what is required in each section, give detailed examples of successful applications, offer proposal preparation sessions, and provide for questions in the application period that are open to everyone. The National Science Foundation (NSF) uses this process for their grant applications to ensure applicants have an adequate understanding of the goals of the grant and the proposal format as well as cut down on the proposals that do not conceptually fit the grant, or do not provide the information needed to evaluate a proposal.

NSTA Past Presidents who reviewed the applications this year for TFS RGO were asked about the applications. Their comments about the applications focus on the need for clearly thinking through the experiment:

> *The application was sufficient. The applicants' ability to filling out the application with major details was the major obstacle or their lack of imagination for having a really good project.*
>
> *My overall impression was that the people involved were very much committed to the project and tried to write good applications. However, some were able to articulate their project better than others.*
>
> *Teams need to think through the whole plan and how it would react in 0g. They need to get info earlier. This year, the timeline was too short. Teachers and students need to get consultation ahead of time (engineering, practicality, safety, solid physics, pre-engineering) and use local resources to actually put the experiments together. It takes time. A lot of the applications seemed rushed.*

To get further insight into the application process we asked teachers if a **more rigorous application** would be a deterrent. About 40% said no, another 40% said yes, and about

20% maybe. The teachers who felt a rigorous application was a good thing said it would ensure you get people who are committed to dong all the work.

> *It will ensure enthusiasm about the program.*

> *Make proposals mini TEDPs so you have a start on that (Technical Experiment Data Package that the teachers and mentor complete before flying)*

> *It needs to be difficult because of the nature of the program but not so hard that would deter teachers because we are so busy. It needs to demonstrate proficiency in technology and the content.*

Teachers who said the current application was fine and should not be more rigorous thought this provided enough information to understand the experiment and the hypotheses.

> *It was doable but sufficient to get the commitment*

The teachers who said "maybe" pointed out that the time it takes to complete a rigorous application would be hard to justify if they are unlikely to get accepted. It was suggested that a pre-proposal be submitted with feedback on whether they should pursue a full proposal. This is similar to what many grants do with a letter of intent, followed by a pre-proposal which is reviewed and either recommended for full proposal submission, recommended with reservations or not recommended.

> *It depends. It is hard to invest that much time in an application for something that may not be accepted. Perhaps there should be a pre-application, then a formal application.*

Many of the teachers we interviewed were eager for feedback on the quality of their ideas and wanted more time in the development process.

> *Make a first announcement in fall. Have an early deadline for proposals with lowest level of detail. Increase level of detail with subsequent deadlines and give feedback.*

> *Give more time from the announcement to the application deadline – it helps to involve the students more.*

> *Make it more about the students; get them more involved in the application process.*

To **improve the process**, teachers suggested that electronic applications, directions to involve the whole team, not just the team lead, streamlining the forms, processes, providing examples of prior successful applications and providing a timeline.

> *Make the application to be done by more than one principal applicant.*

Streamline the barrage of emails early on in the application process.

Put out a checklist of deadlines for the whole process so we know how to plan and can write to that in the application.

We need more information on what we need to do, the initial presentation was not enough. (There was a March 4th webinar on what to expect for people interested in proposing)

Connect previous RGO schools with those involved currently to act as mentors or guides early in the process.

Find way to take the edge off for students and teachers to complete an experiment proposal - website with intro video designed to encourage proposals; examples of proposals - builds - actual experiment

TFS RFO NSTA Past President reviewers had some suggestions for the application process.

There may be a lead role for someone who teaches physics. Make it clear that there are substantive roles for other people so it is not limited to upper level, or AP students. Encourage applicants to looking for collaborators who have an interesting role and can fit it into their classrooms.

It would be an obvious advantage to have more applications in relationship to the quality of the proposals accepted. Also, the increased number of applicants would help justify continued funding of the program. An increased number of applicants also result in more students and teachers collaborating and thinking "out of the box."

NES provides teachers and students with links to abstracts for prior experiments and to resources to come up with ideas for their experiments[5]:

Teams may find researching topics below useful in deciding on a experiment area to study in Microgravity: Physics, Physical Science, Chemistry, and Models (Designs). This link to Prior Campaigns may also help show what kinds of experiments have been performed in the previous years.

Educator Guides to Microgravity may also serve as a guide to choosing an experiment:
- Microgravity: A Teacher's Guide With Activities in Science, Mathematics, and Technology
- International Toys in Space: Science on the Station
- NASA – Microgravity Resources from CORE
- PSA (Personal Satellite Assistant) (Grades 5-8)

Teams are not limited to these areas but are encouraged to look for experiments that can give measurable, repeatable data collection. Emphasize science in the proposal – there should be some theory, postulate, data or calculation that leads you to believe that the phenomena you are investigating will react differently in microgravity than in your 1-G lab. Simply proposing to do something "to see what happens" will probably weaken your proposal's technical merit. A well-stated hypothesis with underlying rationale on why you believe something will happen will probably strengthen your proposal's technical merit.

[5] http://microgravityuniversity.jsc.nasa.gov/nes/theApplication/advice.cfm

We asked teachers and staff about what they thought of offering **predesigned experiments or apparatus** for schools to choose from. People described different ways this could work and the pros and cons of each:

Option	Pros	Cons
Students choose from prebuilt apparatus to design experiments, like the glove boxes which are prebuilt to safety specifications Students would receive specifications for the apparatus so they could build their own version for ground testing at their school	Reduce equipment failures Get better data because of the quality of the apparatus Cut down on approval time since apparatuses would be pre-approved Data could be collected across experiments as background for students in their own design process Emphasizes developing a gravity-related experiment over building the apparatus Removes barriers of cost, expertise and time in building an apparatus to fly	Less open-ended inquiry process since the apparatus becomes a given
Students choose from pre-designed experiments to build and test – replication Data from prior experiments could also be provided Could be combined with prebuilt apparatus	Ensures good research questions and experiments are asked and good data collected Teachers and students gain experience in experimental design Emphasis shifts to understanding the experiment and creating the apparatus accurately so it "works" to collect the data Hands-on experience Are working to a standard –to faithfully replicate the original experiment, an important part of scientific inquiry	Replication – not inquiry based Students may not be interested if they can't ask their own questions
Teachers choose from demonstrations for concepts that may be taught through video or data from a microgravity environment	Teachers have a motivational and effective demonstration to develop student understanding and interest in NASA STEM	Students don't learn the experimental method Students don't design or do research
Students design experiments that are flown by RGO staff or undergraduates who report data back to the students	Students are excited to design experiments that get tested in the unique environments of micro and hyper gravity Cost savings – no trip to Houston necessary More experiments could be flown If undergraduates fly the experiments as part of their own flights, it creates a purposeful outreach and mentorship relationship with K-12 students. Undergrads could communicate with students via the web More incentive for teachers because they would not have to travel to Houston Could be done during the school year without requiring the teacher to be absent from school	Less incentive for teachers since they don't have to fly the experiment

Teacher comments included:

> *Yes! It is incredibly difficult coming up with an experiment that is interesting and ABLE to fly.*

I think it would be great to have a list of experiment ideas, and then have the students design the experiment. Students need to be directly involved in the experiment planning and design. My student was so proud of the fact that his question was the one we selected in 2007.

Yes if it met with our state standards and timing. All teachers do not have science all day, or the same students every day. It must work within our standards and time constraints, as well as include student interest. Gifted students- all students need to feel their opinions count and that they have some choice in their activities.

Allow teachers to make their experiments better or gather new information based on what they learned and come back. (example - a 2-3 year program)

It may be that these represent different options for teachers and students at different grade levels, degrees of sophistication, funding sources, and times of the year. TFS programs DIME and WING have different levels of participation based on the quality of the proposal, the grade levels, and travel funding. Student teams only build their experiment if it is accepted for dropping in the tower.

DIME & WING are components of a NASA competition program that allows teams to design and build a science experiment that will then be operated in a NASA microgravity drop tower facility. This program is a project-oriented activity that lasts one school year for the selected teams. A **DIME** team will be comprised of high-school-aged students while a **WING** team will be comprised of students in grades 6-9. Early in the school year, teams interested in competing will develop an experiment concept, write a proposal for an experiment, and submit the proposal to NASA. A NASA panel of engineers and scientists will evaluate all of the submitted proposals and select the top-ranked proposals for DIME and for WING. These teams will then continue their experiment development and fabrication leading to operation in the NASA drop tower in March.

NASA will provide travel funding to four Tier I selected DIME teams from the fifty U.S. states, Washington DC, and Puerto Rico. Up to four student team members and one adult advisor from each Tier I team will be invited to attend DIME Drop Days in April at NASA Glenn Research Center in Cleveland, Ohio. During DIME Drop Days, the team representatives will conduct their experiment in the NASA 2.2 Second Drop Tower, analyze their data, and tour NASA facilities. Approximately four additional DIME proposals will be selected for Tier II participation. These teams will design their experiments, build it, and send it to NASA Glenn. The drop tower staff will then operate the experiment in the 2.2 Second Drop Tower and provide the video and other data to the team for the team's analysis. These experiments will be subject to the same constraints and safety review as the Tier I experiments. A final report is expected from each Tier I & II team after the results of the drop tower operations are analyzed by the student team.

Recognizing the age of WING team members in grades 6-9, these experiments may be more simple than those proposed under the DIME program for high school students. The NASA panel will select top-ranked proposals from those submitted for the WING program. The exact number may depend on the number and quality of proposals received, but will most likely be more than ten. The selected teams will then construct their experiments, test them at the home location, and then send the experiment to NASA Glenn. The NASA staff will then inspects the experiments for safety and drop the experiments in the 2.2 Second Drop Tower in March and April. Data from the drop will be sent to the team for the team's analysis. After the drop operations are completed, the experiment will be returned to the team. A final report is expected after the results of the drop tower operations are analyzed by the student team.

From http://microgravity.grc.nasa.gov/DIME.html

This model allows students to participate at different levels of work that increase with the extent of the opportunity. The largest group of students will only write a proposal which means they at least learn about microgravity and the drop tower. A smaller group will design experiments that are dropped for them so they have the building, the data analysis, and report writing experiences. The smallest group will travel to Glenn Research Center to conduct their experiment so they have the hands-on, working with NASA personnel at a NASA facility experience.

RGO might actually begin with a requirement for students to participate in DIME, do a DLN microgravity event, a Design Challenge and/or an analysis of data from a previously flown experiment to draw conclusions. These experiences would take less time and commitment but they could entice more people to apply. If the number of applications could be increased for RGO by having a concept paper like DIME/WING, followed by similar levels of participation, more students and teachers could be involved.

Summary of Application Findings

The purpose of an application is to provide indicators that the applicant can accomplish the goals and objectives without knowing ahead of time if they actually can. Both the content and the completion of the application on time, in the proper format with the requested information are indicators of the potential success of the applicant. The undergraduate application is prepared by the students themselves so their knowledge, ideas and capability to carry out those plans can be directly evaluated in the technical paper on the design of the experiment, how they will build and use the apparatus, collect results, analyze the resulting data and do outreach about their findings. The SEED application is prepared by the students and focused on their essay on systems engineering as an indicator of their ability to participate in developing an experiment under the guidance of a NASA principal investigator. In the case of the pre-college programs, TFS NSTA and NES, the teacher is expected to develop the proposal ideas with the students, but write up and submit it for them so the application needs to provide information about the student ideas, and the teacher commitment, understanding and ability to work with the students and the school involvement. The K-12 application can provide information about:

1. The teachers' willingness to put in the time to do detailed work, adhering to NASA guidelines as indicated by completing the application fully and correctly.
2. The teachers' knowledge about gravity, the conditions of the experiment, and experimental methods as indicated by the quality of their students' idea and design for the experiment and their write up of the experiment.
3. How much the students were involved as indicated by a description of which students they worked with, what they did with students to develop the question, methods and design of the experiment, and how they intend to have students build, ground test, connect to the flight week activities, analyze the data and present their findings.
4. The teachers' leadership in the school as indicated by a description of how they have already and plan to involve the school, families and community in each step of the process.
5. The relevant experience the teachers bring to this project as indicated by a description of similar experiences the teachers have worked on with their students

such as design challenges, competitions, NASA projects or other research projects. (This is similar to NSF's requirement for a resume of relevant work.)

The current application provides some of this information but needs more in some areas, especially about how the teacher has worked with students in developing the application and how they plan to continue to work with them throughout the process. The only prior experience asked about is prior RGO participation. For relevant experience, a list of other gravity related and inquiry programs, and competitions could be listed, with an "other" field. This would also serve to alert teachers to other opportunities. Beginning with the goals and objectives, followed by detailed application requirements will get serious complete applications that provide the "down in the weeds" information for review.

Offering multiple phases, levels of opportunities or grade level appropriate activities would require separate applications. Like DIME/WING, the amount of effort to apply would be related to the extent of the opportunity.

D. Selection process

We asked teachers and reviewers about the selection process for TFS RGO and NES, We reviewed the rubrics, checklists and/or processes used to select the teams in all the programs to answer such questions as:

- How are applications reviewed and accepted?
- Does the selection process result in the projects that are worthy and teachers that follow through?

The TFS RGO selection process was planned to be at the NSTA national conference. Past NSTA presidents were invited to review the applications. We interviewed them about the process and their perceptions of the applications. They received the 12 applications ahead of time to read. Given the low number of applications, they made the review process one of providing feedback and comments for the teams that had complete, workable, safe experiments for the eight slots. If more applications had been submitted, they would suggest having a more formal process with a rubric, breaking into smaller groups to read groups of applications and discussing the rubric ahead of time in reference to a sample application to ensure inter-rater reliability.

The NES application evaluation process is defined on the website. Applications are submitted online into a Oklahoma State University secure website. Reviewers then access the applications from the site and evaluate them using a point system.

> Application Evaluation Process
> NASA scientists and engineers with knowledge and expertise in the topic area addressed in the proposal review each team's proposal. Scores assigned by reviewers are compiled and used to rank each proposal against others submitted for competition.
> It is recommended that a team prepare the proposal with the review process in mind.
> - The technical section of the proposal is assigned a numerical rating and is worth 50% of the overall score.
> - The fit with the school's NES plan is assigned a numerical rating and is worth 20% of the overall score.
> - The fit with curriculum is assigned a numerical rating and is worth 10% of the overall score.

- Community involvement is assigned a numerical rating and is worth 10% of the overall score.
- Outreach activities are assigned a numerical rating and are worth 10% of the overall score.

The weighted average of these evaluations constitutes an overall score, which is used to rank-order all of the proposals received. A formal review committee convenes to evaluate reviewer comments and select teams for participation based on the average numerical ranking posted by the reviewers.

SEED Selection Process is briefly described on the website:

> *Teams are ranked based on their communicated understanding of system engineering in the technical workforce and their team makeup as it matches to identified NASA projects.*

Undergraduate proposal evaluation process is described on the website:

NASA scientists and engineers with knowledge and expertise in the topic area addressed in the proposal review each team's proposal. During the Proposal Evaluation Process, each reviewer completely assesses the proposal and "scores" its contents in each of four categories: "Technical/Required Format," "Experiment Safety Evaluation," "Outreach Plan," and "Administrative Requirements." Scores assigned by reviewers are compiled and used to rank each proposal against others submitted for competition.
It is recommended that a team prepare the proposal with the review process in mind.

- The Technical section of the proposal is assigned a numerical rating and is worth 70% of the overall score.
- The Outreach section of the proposal is assigned a numerical rating and is worth 30% of the overall score.
- The Experiment Safety Evaluation section is given a safety rating (safe/go, conditional , unsafe/no-go) that indicates whether the experiment, as presented, is determined to be safe for ground or flight operation.
- The Administrative section is not scored per se, but failure to include prescribed items may adversely affect the ranking of the proposal when compared to other more complete submissions.

The weighted average of these evaluations constitutes an overall score, which is used to rank-order all of the proposals received. A formal review committee convenes to evaluate reviewer comments and select teams for participation based on the average numerical ranking posted by the reviewers.

From http://microgravityuniversity.jsc.nasa.gov/SE/theProgram/teamcomp.cfm

The reviewers are given a **checklist** for each section of the proposal. Each section is awarded points based on the percentage of the total number of points (new proposals have a total possible score of 75, re-flights can score 95). Scores are calculated based on the total number of points for ranking. For example, in the **technical** section, the following is provided: (The first question is given with all its detail to show the support the reviewers have. The other questions are given without the detail)

1. Is the experiment as proposed "good science?" 15 points
   Student experiments need not be "ground breaking science" but should be good, solid research studies.
   Some important points:
   - Does the experiment have a clear hypothesis or research question? (3 pts)
   - Are test parameters clearly identified? (3 pts)
   - Are all other parameters fixed from test to test? (3 pts)
   - Does the proposal fit the "good science" parameter? (3 pts)

   Question 1 score __________ out of 15 points
   Please comment
2. Is it obvious from the proposal that students have done enough background research into the concepts and phenomena to understand what they are proposing and why? (5 pts)
3. Is microgravity required? (10 pts)
4. Is the experiment designed well? (15 pts)
5. Data collection and analysis (15 pts)
6. Reference and bibliography (15 pts)

7. Rational for Follow-On Flight (10 pts) 8. Value of Follow-On Flight (10 pts) Summary Comments

Summary Selection Process Findings

In the process of program development, each of the parts informs the others. Goals and objectives lead to application forms and selection criteria that are then checked back against the goals and objectives to see if they match. This may results in refining the goals and objectives, or the application or the selection process or all of three so that they represent what the program really has to offer and can deliver.

The selection process for TFS RGO needs to be better defined through a rubric or checklist so that reviewers are clear about how to rate the proposals. Detailed descriptions of what is expected in each section and how many points to award need to be provided (as in the RGO undergraduate checklist system). Examples of ratings or “anchor papers” representing different ratings are also very helpful for reviewers. Each proposal needs to be reviewed blindly (no identifying information about the school, team members or location) by more than one person to reduce bias.

Making the process electronic facilitates the review process since reviewers can do it online on their own time schedule, can be reminded if their assigned proposals have not yet been rated, and the proposals are ranked automatically. Reviewers can be added if more applications are received. A subset of reviewers can meet face-to-face to discuss discrepancies in the ratings and to make recommendations for improvement to the highest-ranking proposals. An electronic system also facilitates reviewing a larger number of proposals and culling examples for different levels of quality for future reviews.

The selection process needs to be clear and transparent so applicants can review them in writing their proposal and do internal reviews before submitting them to RGO.

E. Prior to flight

The TFS RGO pilot tested the use of webinars and the NSTA Learning Center to provide support for teams prior to the flight. Questions we asked teachers and staff include the following:

- What kind of support do teachers need prior to flight week to be prepared?
- How has the NSTA webinar approach been helpful for the teachers and staff? Is it effective? Doable? Motivating? Take too much time?
- How does NES support teachers ahead of time?

What kind of support do teachers need prior to flight week to be prepared? Teachers who have developed successful proposals told us their mentors were very helpful, that they needed more on microgravity research to build and refine their experiments, and more organization about the paperwork and deadlines.

Our mentor was extremely helpful with the necessary paperwork.

More help in completing all that crazy paperwork – that was a nightmare!

More on general microgravity research

It would have been a great help to have a list of expectations/dates/schedules for before the flight, during flight week, and after flight week.

Needed more on the NSTA requirements and activities ahead of time

Make sure to not treat teachers like colleagues, not students.

My compliments to the entire NASA RGO/Education staff; you were all so very professional, courteous and helpful.

Given all the teacher comments about the paperwork and requests from the RGO office for additional information that had actually been provided in most cases, we made a list of the paperwork and collected the actual documents from an analysis of the emails, webinars, slide shows and staff interviews to see just how difficult it was. These are presented in the private workspace that is part of this report http://rgotfs.pbworks.com/ A screen capture of the top page appears below:

Collecting and understanding the role of all these documents was no easy task. It was time-consuming to identify them all and identify their importance. Part of the problem seemed to be that they were not categorized. We came up with the two large categories of "Experiment" and "Logistics" with subcategories for Logistics of "NASA forms." "Information, lodging, transportation and shipping," "Team" and "Schedule." We organized it as if we were a team working on an experiment. The RGO staff might choose to organize it differently, but having all the forms and information in one place, organized in a meaningful way, and accessible from the beginning would be very useful for busy teachers and save the staff time in answering questions. Attaching due dates would make it even more helpful. It was suggested by the RGO staff in the webinars that teachers organize all the documents and create a timeline so they did not miss any deadlines. It seems as though this could be provided since it is the same for everyone and would reduce the anxiety and annoyance to teachers.

Drilling down on this sample site yields everything from the critical TEDP to links to the TEDP webinar archived recording to an example of a TEDP. All forms can be downloaded and printed to create a first draft. Links to electronic upload forms could be added. Pictures and diagrams of the glove boxes are all in one place. Maps and lodging information are in a separate section. A sample daily schedule is provided with the caveat that it is subject to change. A comparison of the NES schedules in previous years with the TFS RGO flight week show more similarities than differences so a sample would provide some idea of the schedule for the week. Final, and adjusted schedules could be uploaded to the workspace in almost real time. By using a private workspace, the staff and partners can provide the latest versions of each form and information without layers of approval. Workspaces can be duplicated for each cohort of teams.

RGO Resources

last edited by hilarie@... 1 day ago

Experiment_

- Abstracts of prior experiments
- RGO Lessons to prepare students
- Application
- Selection criteria
- Professional Development including web seminars, schedule, archived video
- NSTA Learning Center
- TEDP Technical Experiment Data Package
- MSDS Materials Safety Data Sheet
- TRR Test Readiness Review
- Glove Box information
- Plane information
- Motion sickness information
- Tool box information and inventory
- Outreach items
- Media
- Presentations about your research (dates, web seminars to prepare, media, ideas)
- Press (NASA press release, sending press back to NASA)

Logistics

NASA

- Medical form cover sheet
- Medical form
- Personal information form PIF
- NASA Guidelines for Imagery Use
- Staff contact information
- Emergency contact information/evacuation form
- Signature form (and media release)

Lodging, Maps, Shipping

- Location: Ellington Field
- Security Badge
- Shipping information
- Area maps
- Hotel information
- Houston area attractions
- Clothing, souvenirs, other info

Team

- Team makeup

Schedule

- When to arrive, what to do when you arrive, flight week activities
- Daily schedule

The **NSTA Learning Center** has a portfolio for teachers to log activities related to their experiments, the learning activities they complete and upload pictures and information about their experiments. In the pilot, teachers were introduced to the NSTA Learning Center through a webinar. Their mentors also participated via Eluminate. Most teachers did not create or populate their portfolios before flight week, so during flight week, the NSTA Learning Center and portfolio were reviewed again. Teachers also did not take advantage of the other resources for learning that are available to them for one year as part of their participation in RGO. It was hoped that this would be an incentive to use the tool and document their work. It may be that specific learning resources related to microgravity should be highlighted for teachers, and that establishing a portfolio needs to be required for final acceptance. Contributions to the portfolio could be specified and monitored for completion. Log entries of meetings with mentors could be created weekly. If contributions are not kept up, teams could be penalized or eliminated. If teams can see each other's updates, they may be more interested in sharing. This would also allow them to learn from each other.

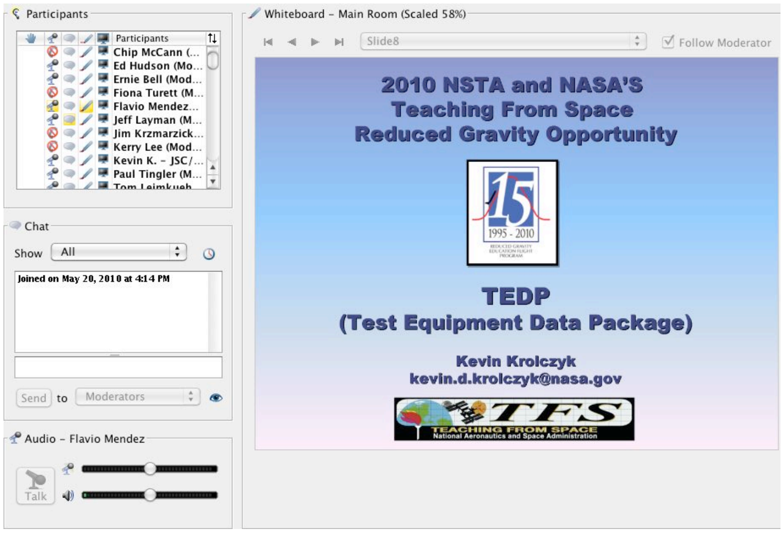
Teachers were very appreciative of their **mentors**. They report that they provided valuable feedback, were accessible, and knowledgeable. There were NO complaints about mentors.

> *We had support from our mentor who showed us pictures of the glove box and sent measurements, offered suggestions, and answered questions. She visited us and saw our set up and 1 G testing.*
>
> *The mentor helped with all our technical aspects, providing tips and a second opinion.*
>
> *Our mentor was great at filling in the blanks for us, especially with the TEDP process.*
>
> *NASA mentor was most helpful since he knew what it would be like and could give pointers.*
>
> *We used Skype to talk to our mentor*

The **TFS RGO NSTA webinars** were reviewed for what was offered, and reports were analyzed for the May 10, 17 and 20 webinars. The following is a list of the scheduled webinars:

- March 4, 2010 7 pm Overview of RGO "What to expect"
- May 10, 2010, 4-5:00 pm Preflight Web Seminar #1 "Where Do We Go From Here?"
- May 17, 2010 4-5:00 pm NSTA Learning Center Orientation web seminar
- May 20, 2010 Preflight Web Seminar #2 "TEDP"
- July 8, 2010 4-5:00 pm T-Minus Three Weeks
- Nov 16, 18, 2010 4-5:30 ET Training for presentations
- Dec 7, 9, 14, 2010 6:30-8 pm ET Presentations

Screen shot of Eluminate session on the TEDP. On the left top is a list of participants. Below that is a chat window where participants can make comments of ask questions. Audio was made available to the presenters, one at a time.



What was most helpful about the online webinars? In response to this question, teachers reported that the most helpful aspect of the webinars was the interactivity. Many teachers commented how helpful it was to be able to ask questions in real time, hear everyone else's questions and to meet the other teachers.

> *Interactivity – being able to have a lot of questions answered, see other teachers' questions, meeting everyone*
>
> *Keeping us on track, being told what to expect*
>
> *Kept us informed about changes*
>
> *Discussing details*

Some teachers felt the webinars were less helpful because they got the information through emails.

> *Not sure, I think I got all the help I needed, except dimension of box*
>
> *Only a little helpful, not that useful, difficult to get everyone to go to*
>
> *The one prior to the application deadline was great to tell me what to do for the application The ones later were kind of repetitive.*

What else would you like to see included in the webinars?

> *Timelines and schedules prior to flight week so we can better plan and prepare*
>
> *More mentor time would have been helpful, especially up front*
>
> *More information on fund raising ideas*

Maybe a video of a team working putting their experiment into a glove box just to get a better feel of it. Not just pictures. More information about the glove box, especially dimensions

I think a video of the plane going through about 10 parabolas would have been great for getting an idea of how much time the flight takes for a pre-flight activity. I would've been much more prepared for the flight that way. (Note: Video is available on the microgravity website)

NSTA moderated the webinars and **created reports** on the May 10, May 17 and May 20 webinars. Participants completed evaluations. The results were provided by NSTA and appear below.

Date	Title	Attendance	Evaluations
March 4	What to Expect	-	-
May 10	"Where Do We Go From Here?"	37	33
May 17	NSTA Learning Center Orientation web seminar	31	23
May 20	Preflight Web Seminar #2 "TEDP"	38	25
July 8	T-Minus Three Weeks	27	16

The percentages of participants who agreed or strongly agreed with each statement are given below. The questions varied slightly with the session so blank cells in the table indicate the question was not asked. The webinars were rated above average for the most part. Some participants were unclear about the Learning Center. It was suggested that this webinar be first, be slower paced, and be more clearly related to the RGO work.

	May 10	May 17	May 20	July 8
The web seminar met my expectations.	100%	61%	80%	100%
The content of the web seminar was relevant to my team's preflight activities.	100%	83%	96%	100%
The web seminar was well organized and flowed logically.	94%	74%	92%	100%
The web seminar was delivered at an appropriate pace.	88%	74%	88%	100%
The visual aids used were helpful.	97%	95%	96%	100%
The NASA/NSTA facilitators encouraged participation throughout the web seminar	97%	96%	96%	94%
I was comfortable asking questions when needed.	97%	91%	96%	100%
There was enough time to ask questions.	94%		93%	94%
The web seminar was informative and I believe it will help my team to have a successful flight this summer	100%		92%	92%
The orientation allowed me enough hands-on practice to feel comfortable using the Learning Center resources and tools.		74%		
The materials will be helpful for future		91%		

reference during my participation in the program				
The hands-on exercises were useful.		78%		
I will most likely continue to use the NSTA Learning Center for my professional development beyond this one-year opportunity.		74%		
There was enough time provided to learn the subject matter covered in the orientation		70%		

Presenter Evaluation

Percentage rating excellent or good (5, 4)	May 10	May 17	May 20	July 8
Knowledge of subject	100%	91%	100%	94%
Clarity of explanations	97%	73%	92%	94%
Responsiveness to questions	100%	96%	96%	94%
Voice projections/articulations	94%	91%	96%	94%
Pace of delivery	91%	61%	96%	94%

Comments and Recommendations from teachers about the webinars
May 10

- *In a future web seminar, if more than one presenter is available, while the main presenter goes over the slides, the other(s) can answer questions via chat.*
- *In a future web seminar, extending the time for questions may be favorable.*
- *In a future web seminar, presenters may consider responding to specific teams' questions individually via e-mail or phone at a time after the web seminar.*

May 17 comments

- *It was difficult to keep up.*
- *This is not what I expected to learn about today. I did not realize its focus was on professional development and reporting this.*
- *Seemed to be a sales presentation for the most part.*
- *In a future web seminar, the presenter should check randomly with the audience to make sure that the pace is appropriate for all to follow.*
- *In a future web seminar to this audience, messaging might need to be altered to make it clear that the Learning Center resources are a FREE benefit to participants and not resources they are required or encouraged to purchase.*
- *If a similar web seminar is offered to TFS-RGO participants in the future, the leadership team might consider offering the Learning Center orientation on a different date during the program sequence. Its scheduling between the first two Preflight web seminars might have confused the participants regarding the role and use of the Learning Center e-PD resources.*

May 20 comments

- *He did a fine job. The telephone connection was poor.*
- *Seemed he was reading the slides for the first time when he was doing the presentation.*
- *Just a little worried about the logistics of everything and the exact requirements on our end. My team is still not sure what we need to do with the Learning Center*

material.

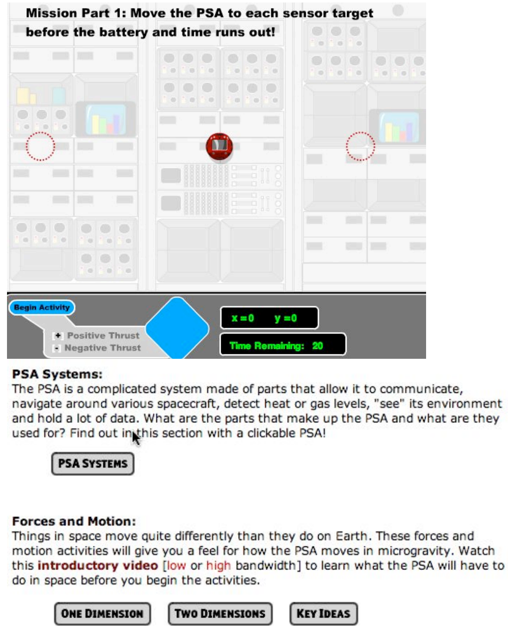
- *In a future web seminar, the presenters may consider encouraging participants to submit their questions about the TEDP in advance.*
- *In a future web seminar, the NSTA moderators will recommend participants to share messages via chat within the "breakout room" and not as private messages that all Eluminate Moderators can see.*
- *The NSTA team will contact the team leads and share ideas of how they may use the Learning Center resources, e-print assets, and tools as they work on their experiments.*

July 8 comments

- This program was well received by the participants and may be used in the future as a model to share with presenters if this program is repeated next year.
- One of the participants indicated that there was not enough time for questions during the program. In the future presenters may consider staying for a few minutes after the program is over (15-20 minutes) to answer additional questions from those interested participants. This is common practice in NSTA public web seminars that seems to work well.

How does NES support teachers ahead of time? The NES website provides topics to research, prior campaigns (previous experiments), and lessons to use with students. The content resources provide teacher background, student activities and simulations.

- Microgravity: A Teacher's Guide With Activities In Science, Mathematics, And Technology This educator guide contains excellent background information accompanied by classroom activities that enable students to experiment with the forces and processes microgravity scientists are investigating today.
- International Toys in Space: Science on the Station The educational video "International Toys in Space" shows International Space Station crewmembers and students back on Earth co-investigating the behavior of toys in space. Video program segments show the behavior of the toys in 1 g (Earth's gravity) and then their behavior in the microgravity environment of space. Activities, brief descriptions of what happened during the ISS flight, and science and mathematics links are available in the International Toys in Space Video Resource Guide.
- NASA - Microgravity Resources from CORE This site lists microgravity-related videos and resources available for purchase from the Central Operation of Resources for Educators. Visit the CORE Web site for more information.
- PSA (Personal Satellite Assistant) (Grades 5-8) Explore math and physics with a robotic helper.   **http://psa.arc.nasa.gov/**
  The simulations on this website are designed to develop students' understanding of force and motion in a microgravity environment. Students make predictions, see demonstrations and then control the "assistant" based how force and motion work in microgravity.



Teachers can also schedule events from the Digital Learning Network on gravity:

Toys in Space Investigation In this investigation students play the role of scientists and engineers in examining the physics of popular toys and games in the classroom and try to answer the question: Will this toy work in microgravity and how could the toy be modified or engineered to perform better in the microgravity environment? Grade Level: 04, 05, 08, 07, 09, 06 Subject Category: Physical Science Unit Correlation: Exploring NASA Missions, Exploring Engineering and Technology, Exploring Space, Special Programs

Humans in Space You have just been selected as the next astronaut to spend six months on the International Space Station. How is your day-to-day life going to be different? What changes are you going to have to deal with living in space? Grade Level: 5-8, 9-12, K-4 Subject Category: Earth Science, Life Science / Biology Unit Correlation: Exploring Space

Reduced Gravity: Effects on the Human Body What are the effects of long-term exposure to a reduced gravity environment on the human body? Grade Level: 5-8, 9-12 Subject Category: Life Science / Biology, Physical Science Unit Correlation: Exploring Space

Humans to Mars It is the year 2020 and you have been assigned to one of the first engineering teams to begin planning a manned mission to Mars. Your team leader has asked each of you to make a list of the five most critical issues that you feel need to be addressed. What does your list look like? Grade Level: 5-8, 9-12, Post Secondary Subject Category: Earth Science Unit Correlation: Exploring NASA Missions, Exploring Space

Planet Hopping: Exploring the Solar System with Mathematics How does the mass of each planet in our solar system relate to gravitational force? Grade Level: 03, 04, 05, 08, 07, 06 Subject Category: Physical Science, Math Unit Correlation: Exploring Space

Summary of Prior to Flight Findings

Between acceptance and flight week, teachers need to work with their students to build the experiment and do ground tests. Teams report that working with a NASA mentor during this period was very helpful for getting feedback on the experiment, and understanding more about the requirements. Teams must provide the information for the TEDP Technical Experiment Data Package to the mentor, who writes up the plan. This is submitted to flight ops 6-8 weeks before flight week for review. Teams must also prepare for a TRR Test Readiness Review that takes place the beginning of flight week to ensure the experiment is flight worthy.

Teachers report that the paperwork and requirements are complicated and difficult to follow. This led us to review the requirements, forms, and information, then categorize and present it in a virtual workspace. In the webinars, teachers frequently asked questions that had been answered in emails or the webinar. In the evaluation at the end of flight week, they said they wished they had known things that they were actually informed about. Providing a web space with all the information and due dates could relieve some of the participants' anxiety and staff time in responding to questions. There is so much novelty for teachers during this period that they need a place where everything is stored to be able to revisit information as a question arises. They are also perhaps paying less attention to the logistics because of their focus on getting the experiment right. The TFS NSTA RGO teachers may also be fundraising to pay for their transportation and lodging costs.

Part of the TFS NSTA RGO pilot was to provide support for teachers during the period between the acceptance and flight week. The approach involved doing webinars on the requirements, the NSTA Learning Center, and the TEDP. For the most part, teachers found these valuable for being able to ask questions and interact with other teachers and for keeping on track with the schedule of requirements.

The NSTA Learning Center has the potential to be very helpful to teachers in learning the content, and in logging their activities in their PD plans. It was not utilized in this period. Some teachers did not see it as a priority with everything they had to do for NASA and for the experiment. Others did not understand how to use it or its purpose. It was reviewed and emphasized during flight week so it will be important to look at how it was used after that, and to see if the value increased to them. If the Learning Center had all the documents and resources, like the web space created here, perhaps they would access it more.

Teams will present their findings in nationally advertised NSTA webinars in December. This is an opportunity for the teachers and students to share their experiments. It is hoped that this opportunity will be part of their outreach activities and encourage good follow up on their experience with a wider audience. It will need to evaluated in light of their other outreach activities.

NES provides four in depth resources for teaching activities, background for the teacher and simulations on microgravity that are very good. DLN events on microgravity are also available. These resources could be identified in the announcement, with a webinar offered on these and other resources. Additional webinars with Subject Matter Experts on microgravity concepts, or microgravity experiments by NASA PIs from SEED, or faculty and undergraduate students on their experiments could be offered, with a lot of time for questions so teachers can be active learners.

F. Flight week

The evaluation of flight week was based on observation of five of the six days, interviews with staff and teachers, surveys of teachers and analysis of the materials. Questions included the following:

- How closely aligned were teacher expectations and the actual experience? Did teachers achieve their objectives? Science? Personal? How does each of the activities contribute to the goals for the teachers?
- Were there any missing pieces? Something they would have liked to occur? Speak with more engineers? Scientists? Prep time, more or less? Some groups are ready to go, others have to scramble to get ready.
- Were they able to keep in touch with their students with it?
- What was the best preparation they had for this experience?

We asked teachers to evaluate each of the **flight week activities** on a scale of 1-10. The activities were taken directly from the agenda. All the activities were rated above average.

TFS NSTA teacher evaluations of flight week activities

	Average
Preflight brief	9.5
Work on experiments	9.3
JSC Tour	9.3
Work with mentor	9.2
Spatial disorientation class	9.2
TRR – Test Readiness Review	9.1
Neutral Buoyancy Lab Tour	9.1
Team presentations (Friday)	8.9
EF and safety briefing	8.9
Motion Sickness video and talk	8.8
Post flight debrief	8.6
Teaching from Space briefing – Becky	8.2
Rocket Park Tour	8.2
NSTA E-learning Briefing - Flavio	8.0
ERC briefing - Elaine	7.8
PAO Journalist/Media Briefing	7.3

Were there any missing pieces? Something they would have liked to occur? Speak with more engineers? Scientists? Prep time, more or less? Some groups are ready to go, others have to scramble to get ready.

We asked teachers for **suggestions** to improve the flight week activities. Many thought the time could have been shortened to one full week instead of six days with the weekend included. This will be discussed in more detail in the timeline section. As seen in the rating above, the teachers thought all the activities were valuable. They offered some specific suggestions in the following comments:

The space on the plane is severely limited with the glove boxes. Perhaps, have one less group fly each time?

Allow previous teachers to participate as leaders, not limited to being Alternates (we know who gets motion sickness!)

Some of the communication from RGO was highly directive, almost disrespectful. Adult-adult communication works better.

When we got to Houston, it turned out that many of the teams had been given different options like working with another school, or including other students, or a local museum. It would be good to know of all of these options ahead of time.

Be sure teams that do hyper-g experiments have a flight crewmember to assist first-time fliers.

The full flight week schedule is on the workspace. With the exception of the hypobaric chamber, the schedule is very similar to the undergraduate and NES schedules. The K-12 schedules include professional development in addition to the tours. We asked NES and TFS NSTA teachers how long flight week needed to be. Eight thought it was good the way it was. Six through 4-5 days was plenty. Others made individual comments or did not respond.

- *Was good the way it was (8)*
- *4 or 5 days (6)*
- *Depends on flight days. It should have more flight days for better data collection.*
- *Would be nice to eliminate weekend dead days - but see why they were needed.*
- *Could have done it in slightly shorter time, but probably needed whole time to prep for experiment as we discovered new information. Maybe start on Saturday.*
- *Good length as is with flying early in week to do more data analysis afterwards*
- *Schedule TRR one day later*
- *Staying over the weekend adds a lot of cost. I think for most teams $ are an issue and may be a/the limiting factor for possible future participation. Print certificates of participation*

How ready was your experiment when you arrived? All the teachers except one reported their experiments were 70% ready when they arrived. One of the reasons for the weekend stay given by staff was that the time was needed for the teams to get their experiments finished before the Test Readiness Review on Monday morning.

How ready upon arrival	# Teachers
51-55%	1
56-60	0
61-65	0
66-70	0
71-75	10
76-80	2
81-85	5

86-90	10
91-95	2
96-100	8

Most of the TFS NSTA teachers kept in touch with their students during the week through email, Facebook, phone calls, and texting. Two of the teams had webinars with their students. So even though it was summer, all but five people reported staying in touch with their students. Examples of these websites and other presence on the web would help new teachers to see what is possible and how to involve their students and the community throughout the process.

> *We have a dedicated Facebook website that we are using to keep everyone up on our activities.*

Means of communication	# Using
Email	16
Facebook	12
Cell phone	11
Webinar (NSTA help)	8
Internet	7
Texting	6
Internet	7
Twitter (photos, Skype, wiki)	4
None	3
After this week	2

One teacher shared this website. He has flown other experiments and participated in other NASA activities.

To know what we might suggest people do before RGO or what to look for in applicants we asked, **"What in your prior experience best prepared you for RGO?"** Some of the teachers had had research experience, either in jobs before they became teachers (3) or on other projects (MIT, DIME, other university). Most people said there were no comparable experiences. The agriscience teachers made a special request to the other teachers on the last day to seek out agriscience teachers in their region and tell them about RGO because the whole approach in their discipline is problem solving.

Nothing, no comparable experience	10
Swimming in a pool, scuba diving, Splash mountain, riding roller coasters	4
Working with people, Networking with other educators, Knowing your place as a follower and as a leader	4
MIT projects, Working with researchers in university, DIME	3
Did research after college	3
Various presentations	2
Openness to new experiences, flexibility	2
Piloting skills, Commercial flights	2
Lab activities, Knowing how to translate math to students, Teaching shows you that anything is possible	3
Instrumentation, design, electronics, machinery; Home projects	2
Astronomy background	
Agriscience teaching	
Used to doing paperwork	

Zero-G Corporation offers educational opportunities for teachers. The following is taken from their website: http://www.gozerog.com/Uploads/file/ZERO-G%20Program%20Descriptions%20-%20Grant%20Apps.pdf

> The professional development program is flexible and provides a range of depth. Program designs include:
>
> One-Day Lab – This is a half-day workshop including the math and science of micro- and hyper-gravity environments and parabolic flight (the means through which different gravities are created). It also includes a mission briefing on the safety requirements, time to select from pre-defined experiments, the parabolic flight and post-flight recognition ceremony.
>
> Comprehensive Professional Development Program – This design may require a comprehensive two-month preparation period including online modules, educator workshop, experiment design/implementation, and classroom work with student participation. The pre-work period is followed by a full day for the parabolic flight including a recognition ceremony. After a brief period during which post-flight resources have been incorporated into participant classrooms, there is an online summative evaluation. As an additional benefit, ZERO-G has partnered with Purdue University Calumet to offer college credit hours for qualifying educators in this extended program.

The One-Day Lab is offered in different cities. The plane goes there. The same is true of the comprehensive PD program. The full day briefing is held at the beginning of the two-month preparation period in different regions. The teachers then return for one day when they fly their experiments once with 20 parabolas. The RGO program has 30 parabolas and the experiments are flown twice.

Since RGO leases the Zero-G plane by the week (for the last two years), this is a constraint. They need to schedule teams to take advantage of the full week. Their experience with the undergraduate program has led them to have experiments fly twice which changes the equation for scheduling teams to fly. Several of the teachers were asking for even more flight time. The Zero-G program is focused on the flight and does not offer tours of NASA. They are not required to follow NASA procedures such as the TEDP, TRR, medical form, etc. The idea of predefined experiments could cut down on the review time and resulting issues that teams have to address, but these were all handled very smoothly by the RGO staff. The TRR took less than two hours, and the only downside was that it was in the hot, noisy hangar so teams were not able to hear each other. If they had been able to hear each other it would have been interesting to them. Perhaps a dry run of the TRR could be held online so the teams could hear about each other's experiments. This could also raise issues that need to be resolved before flight week. In the NES and undergraduate RGO, teams are required to create videos of their experience, from acceptance through flight week that they present the last day of the week. The NES teachers report being very busy with working on their videos in the evening during flight week. If this becomes a requirement for TFS NSTA RGO, then they will need that additional time.

Summary of Flight Week Findings

On a scale of 1-10, teachers rated the flight week activities 7.3 or higher. While some said the week should be shortened to 5 work days (6), others felt arriving on the Friday before was fine (8). Most report their experiment was 70% or more ready to go so they may not have needed the weekend days to work on it. From talking with them at the event, most did tourist activities in the area over the weekend. They offered suggestions to tighten up the schedule, make all the information available ahead of time, and have a crewmember assist during hyper gravity times on the plane. Several wanted more parabolas to collect more data, to fly earlier in the week, and more than once.

Most teachers kept in touch with their students electronically during flight week suggesting that the summer flight time did not interfere with that live communication.

Depending on the options offered to teachers in the future, the length of the flight week could be adjusted.

G. Follow up after flight week

In this section we explore what the teacher teams do with their students and school before, during and after flight week. In the past, it was sometimes difficult to get information from teams about what they did after flight week since communication subsided, and there was little incentive to complete follow up surveys. The TFS NSTA pilot made follow up part of commitment teachers agreed to and has scheduled webinar presentations from each team in December of 2010. We saw from the data on how teachers kept in touch with their students that many had established communication channels with their students, and some had created web spaces for their schools and others to follow their experiment.

What do teachers do with students and their schools after the flight week? Who do they share the experience with? NES teachers reported a variety of follow up activities. Some arranged for the students to present their experiments to other students or parents. Some set up web spaces for documenting their activities. One school started an after school science club and a new unit on motion and forces. Below are some of the best examples of follow up.

> *We involved the rest of the school by showing our experiment and presentation in the multi-purpose room.*
>
> *I was able to share the results with my students and put together a multi-media presentation shared at our science fair and with our staff. A local weekly paper followed up.*
>
> *I created a wikispace for before during and after the flight that was used by teachers, students, parents, and the community.*
>
> *We had "space nights" to involve parents and students.*
>
> *In the classroom, we used ActivBoards, to look at the data, interpret and compare to our hypotheses. We had lessons pertaining to the experiment and its outcome. We wrote creatively about what we saw in the photos and videos. We presented the photos and videos to staff and explained the experience.*

Our experience led to an after school science club. Also, we are adding a physical science module (motions and forces) to our fifth/sixth grade curriculum.

We created a wikispace. Now the kids want to create their own wikispaces for events in their own lives!

We partnered with another school on this so collaboration was huge.

We actually included nearly all fifth and sixth grade classes and teachers in experiment design (I shared my multi-media presentation from the 2007 experiment and did a lesson on motions and forces for all 10 science classes). They were also all involved in the results and seeing the final multi-media presentation. Faculties in both our high school and middle school as well as our administrators viewed the presentation as well.

Aside form the verbal presentations and discussions...the Wikispace was complete with daily updates and photos of the entire experiment. It included a contest they could share with their students; it was in the newspaper, etc.

The RGO flight team and student scientists are scheduled to make multiple presentations of their experiment and findings during Sci-PORT's Space Day. Additionally, select students and flight team members will accompany Broadmoor counselors as they present the NES program to their feeder elementary school's 5th graders.

The students traveled to a local water department to view fluid dynamics on a municipal scale.

We partnered with their local cable company to have the teleconference recorded. Students are presenting a documentary video revealing their work to parents and the school community and were interviewed for local TV and news media. Other students presented at the KSC student symposium and to the school board as well as kindergarten classes in their district. They also blogged about their experience during and after the experimental flight.

The team will present their findings at the NASA Ames Virtual Student Symposium as well as traveling to KSC to present to a panel of scientists and peers and the National Student Symposium. They also will hold a school assembly attended by the school community and NASA Ames members and present once more at the NASA Family Night.

We plan to talk to different high schools and universities in our area to promote the program as well as professional organizations

The **TFS NSTA** teachers reported on their plans for follow up, including analyzing and sharing results with everyone who helped and who is interested.

We plan to involve other engineering teachers in our school and region by letting them know about what we did and doing presentations

We will review the experiment, prepare the results for analysis, and involve the students in reviewing and sharing the whole experience

We have presentations with schools/district office, school board, and the planetary science class scheduled

We have already been comparing our experimental results from the two flights, sharing personal experiences, and sending photos to students, peers, colleagues, etc.

Our plan is to work with students to analyze data and make suggestions on how to make it more rigorous and gather new data for next year

Undergraduate students are encouraged to create an outreach website, in addition to actively engaging younger students in thinking about the experiment and STEM. They are required to keep an Outreach Event Log with the following information for each presentation:

Outreach Log Sheet		
Identifying Info		
Reporting Person Info: Your Email & Home Phone:		
Your Name:	Your University:	Your University Zip:
Event Title:	Event Date:	Event Duration:
Type of Event:		
Location		
Name of Event Site or School:	Event City, State, Zip:	
This site or school at which this event was conducted is a(n):		
Approximate Participant Count		
Direct Participants (Definition: those whose name, school, organization is known and there is interaction between the participant and the team.)		
· K12·	Teachers – how many?	
· Higher Ed Faculty – how many?	· Students – how many?	
· Other Professionals – how many?		
Indirect Participants		
Definition: people whose name, school or organization is not known.		
· General Public – how many?	· Other Professionals – how many?	
· Others connected by webcast, TV or Radio broadcast, etc – how many?		
Additional Comments		

NES provides teams with **RGO Report Guidelines.** They are reviewed for completeness in each area.

Title Page (Team name, Title of experiment) **Introduction** **Abstract, updated if needed** **Statement of the research problem:** History of the Problem (Include, perhaps, past attempts at solutions) Work in your sources. (Include tables, graphs, pictures) **Method:** How did your research begin? Describe your experiment setup. What were your hypotheses in your classroom? What research did you do prior to flight to prepare? What tests did you do in your classroom to prepare? What were the results in 1g? Did you prove or disprove your hypotheses? **Results:** What were the results in 1g? Did you prove or disprove your hypotheses? What were the results in 0g? Did you prove or disprove your hypotheses? What were the results in hyper-g? Did you prove or disprove your hypotheses? **Discussion:** What were your challenges? What were your successes? **Conclusion:** What did you learn? Now that you have tested your experiment... What you change if you were to re-test the experiment again? How would the research you conducted contribute to NASA's goal of heading future into our universe? Looking back at your NES/SEMAA RGO application you listed outreach items your team would complete prior to and after completing the NES/SEMAA RGO research. What outreach did your team complete? **Bibliography:** Include all sources - websites, books, etc **Acknowledgements:** School website with NES/SEMAA RGO info, eFolio site entry address, NASA Mentor, etc.

Summary Follow Up Findings

Key elements of follow up in programs are present in the TFS NSTA and NES models:

- Up front commitment to follow up by the teachers and the school principal (in writing)
- Development of a plan for follow up
- Preparation of a report and /or video that can be used for follow up
- Providing interested audiences (NSTA webinars) and training for presenting

The excitement teacher express at the end of flight week is an indication of their intention to follow up. The involvement of their administrator also increases the likelihood they will follow through. The more they involve the school, parents and students in the whole process before flying the experiment, the more likely they are to follow up because they have created the expectation. The problem remains how to obtain information about what they do and with whom – the kind of data collected in the undergraduate Outreach Log Sheet. This could be collected in an additional section to the NES Final Report Guidelines, or as part of the slide show for the December webinars.

H. Overall Timeline

What is a reasonable timeline for teachers from when they hear about it to when they apply, to when they fly, to when they complete the follow up? To answer this question, we asked TFS NSTA teachers, NES teachers, and staff what they thought was a reasonable timeline for the entire program. While we have touched on the length of time of different events earlier in this report, in this section we address the program in its entirety.

The **TFS NSTA** timeline for the 2010 RGO below was constructed from emails, webinars and interviews. It was reviewed by NSTA and RGO for accuracy.

Date	Activity
Feb 1	NSTA announces call for applications to 18 district directors
Feb 1	NSTA emails 300 CAGs with request to distribute information to their networks. Emails 50 schools with multiple NSTA teachers, or aerospace interests. Notice sent out to Science Matters network.
March 4	Webinar: Overview of the program for interested applicants
March 10, ext. March 17	Due: Applications The date was extended to March 17 for those who heard about it late
March 20 April 5-7	Applications reviewed at NSTA by past presidents. Continued April 5-7 and by TFS and RGO staffs
April 14	Teams notified of selection
May 3	Teams matched with mentors
May 10	Due: Teams contact mentors
May-June	Students work on experiments with faculty advisors and mentors
May 10	Webinar: What to expect
May 17	Webinar: NSTA Learning Center
May 17	Teachers establish Professional Development plan in NSTA Learning Center
May 20	Webinar: TEDP
May 21	Due: PIF Personal Information Form, Signature Form
May 26	Due: Abstracts
June 3	Due: TEDP information to mentor, hardware ready
June 16	Due: TEDP from mentor to RGO
July 8	Webinar: T-Minus Three Weeks
July 16	Due: Medical forms, evacuation plan, dinner RSVP
July 20	Due: Experiment arrives in Houston
July 30-Aug 7	Flight Week
Aug - Dec	Follow up data analysis with students
Nov 12	Due: Interim Professional Portfolio
Nov 16, 18	Webinars: Preparation for presentations
Dec 7, 9, 14	Webinars: Presentations by teams
Jan 14	Due: Individual Professional Development Portfolio Export

The areas of concern by teachers were:

- Heard about the program too late to involve students
- Difficult to build and test during end of year testing time
- Need a timeline of due dates for forms from the beginning (Note: like the one above)

The **NES timeline** is published on the NES website. It is subject to change, but has been fairly stable for the last three years. This timeline was developed over several years based on feedback from teachers about the time needed for the different phases of the project and the time of year that worked for them to participate. Originally the application due date was in September with acceptance in October and flight week in February. The teachers said they needed time after school started to teach students about gravity, and come up with an experiment. Due to school holidays, they wanted more time after acceptance to build and test the experiment so flight week was moved to April which still gives them one to two months for follow up. NES teachers in schools that end in May or early June say they would like more time for follow up before the of the end of the year. One team had to cancel because their school said they could not attend flight week because it was during "test prep" time. A feature of the NES program worth noting are the videoconference where students present their experimental hardware to the reduced gravity staff in February to ensure that students are involved and to give them a direct connection to the NASA staff. Also, each team creates a video that is due the end of flight week that includes footage of the preparation as well as the flight week activities.

NES Reduced Gravity Opportunity Timeline (Subject to Change)[6]

Date	Activity
October 7, 2009	Proposal Due
October 19-23,2009	Video Conference Test Calls
October 27, 2009	Teams notified of selection
October 2009 - May 2010	NES students work on experiment
November - December 2009 (as scheduled)	Video Conference Event #1 Overview of Microgravity & RG Program
November 24, 2009	Abstracts Due
January 20, 2010	Physicals Due
Early February 2010	Hardware Ready
February 2010 (as scheduled)	Video Conference Event #2 NES Students' Hardware Presentation to RG Staff
February 15, 2010	All Paperwork Must Be Complete
February 18, 2010	TEDP Due
April 12, 2010	Experiment shipped to arrive in Houston
April 22 - May 1, 2010	Flight Week, Video due at end of week
May 28, 2010	Final Report Due

The **SEED** Systems Engineering Educational Discovery timeline is October to June, like the NES timeline.

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[6] **http://microgravityuniversity.jsc.nasa.gov/nes/theProgram/program_timeline.cfm**

Date	Activity
October 27, 2010	Proposal Due
December 8, 2010	Teams notified of selection
Early February 2011	Physicals Due
February 16, 2011	TEDP Due
Late February 2011	DLN Event #1 - NASA PI Connection
Early March 2011	DLN Event #2 - Subject Matter Experts
March 31 - April 9, 2011	Flight Week
June 17, 2011	Final Report Due

The timeline on the RGO side is laid out below for the undergraduate program (subject to change of course). The first column refers to when they send information out to team members. The second column is the information the timeline for getting information back. Many parts of this schedule seem to work with both the TFS and NES schedules.

	Info out Flight minus	Info in flight minus
Medical	1 week before Mike's deadline	Up to Mike
Hotel Reminder	8 wks	
PIF, UG transcript, Sig		8 wks
TEDP	10-15 wks	6 wks
Countdown/Shipping	4 wks	
Prior to Leaving	4 wks	
Badge Request	3 wks	2 wks
Evacuation Plan	3 wks	2 wks
Dinner RSVP	3 wks	2 wks
JSC emergency contact	2 wks	
Flight Meds Info	2 wks	
Schedule	1 wk	
PR3 we flew	Flight plus 3 days	
Final Report	Flight plus 3 days	Flight + 2 months

The **teacher survey results** are shown in the table below. We asked them when was a good time of year for each of the phases. Since we surveyed both TFS and NES teachers, the timelines somewhat reflect their experiences with the timelines they are familiar with: August to June, or January to December. Many of the teachers preferred the summer time slot for flight week.

	Advertise	Apply	Build & Test	When to fly	Follow up
March					
April					
May					
June					
July	2				
August	5				
September	2				1

October	7	3		4	3
November	2	2			
December		1		1	
January	6	3			
February	4	2	1		1
March		1	1	6	
April	1	1	1		
May		1	2	2	
June				5	1
July				15	
August				3	

Summary of Timeline Findings
In interviews, teachers and staff suggested continuous advertising of the program through a website, direct mailings (like the undergraduate program), social media, STEM teacher publications and listservs, STEM organizations and NSTA mailing lists. Whether the timeline is August to June or January to December, or both, having that information available all the time will likely increase the number of applications since teachers can plan ahead. Particularly with the costs associated with flight week, teachers need to be thinking ahead about how to get funding and integrate the experience into their curricula.

If funding permitted, it might be best to offer the program in both the August to June and January to December timeframes since some teachers clearly prefer the summer flight week and others like it during the year so they can do follow up before the year ends. It all depends on the teacher and how he or she sees it working best.

If modified programs are offered, such as flying demonstrations or pre-defined experiments, the timeline could be much shorter because students would not be building the apparatus and ground testing the experiment. Teachers would need less time to prepare the application because they would not be involving the students in asking questions. They could even wait to involve the students until they were accepted.

I. Evaluation

In this section we examine the results of the program to date. Although the TFS NSTA RGO was a pilot, NES has offered RGO experiences since 2004. We were able to retrieve the evaluation data from NES for 2004-2010. We also asked the TFS NSTA teachers about the effects of participation on their students and on their own teaching.

- What are the effects on the teachers, their schools and their students?
- How are the effects currently evaluated and reported?
- How do we ensure cooperation in evaluation from the participants?

TFS NSTA RGO teachers reported that participating in RGO had (or would have) a great effect on their **students'** knowledge; 8.8 on a scale of 1-10.

	5	6	7	8	9	10	Ave
How much did it affect your students' knowledge of STEM topics? (1-10)	1	0	0	11	5	8	8.8

- *It helped them to build the project. Determine cause and effect, test the design, and apply science to real life.*
- *It inspired them to want to do more*
- *The math classes will break down the data so they will be seeing how math gets applied in an interesting context*
- *They were very excited about designing a research project*
- *This has provided the students with an experience that they will take with them the rest of their lives. This program has allowed them to make connections that they would not have been able to make otherwise. It has allowed them to mature, and to make higher goals. In their own way, they have become "heroes" to the rest of the student body. It has inspired the rest of the students to achieve and to want to participate in other NASA challenges.*

In what ways does it affect student knowledge? The effect on student thinking most often mentioned by teachers was their understanding of research and the application of ideas they learn about in school. Teachers also noted they learned to think more spatially because of building the experiment.

- *They know more about what real research is actually like, ups, downs, problems, and successes*
- *Direct application of classroom theory, Intro/application to previous topics (in physics) It stimulates their learning, better understand concepts, have to do math to see outcome*
- *Now we have 1st hand video! It will become real to them! We tested <u>their</u> experiment*
- *Made them think spatially! Ours did the design and build*
- *Awareness of what is possible, opportunities*
- *They learned about microgravity*

In what ways does it affect teachers and their instruction? The findings in this section come from interviews and surveys with TFS NSTA and NES teachers who participated in RGO. We asked them about the connection to their curriculum, how much they involved other faculty, what specific areas of their curricula that RGO supported, and how they have benefitted from participation in RGO.

We asked teachers who had participated in RGO how they connected RGO to their curricula as one effect on instruction. They reported a good connection to the curriculum as indicated by a rating of 8.5 on a scale of 1-10. We also asked how they involved others in the school. They rated this highly as well - 7.7/10.

How much did your experiment connect directly to your curriculum? (1-10)

	2	3	4	5	6	7	8	9	10	Ave
How much did your experiment connect directly to your curriculum?	1	0	0	2	0	4	4	8	12	8.5
How much did you involve other teachers and students in your school?	0	1	0	2	3	4	4	1	6	7.7

How does RGO contribute to your curriculum goals? TFS NSTA teachers made many connections, including the scientific method and teaching gravity, fluids, and motion. Math teachers were involved in data analysis.

> *Students see their teachers doing real world experiments*
>
> *Strengthens our project-based curriculum goals in general*
>
> *I teach our experiment in a kit that covers all aspects of fossil fuels and biofuels. I will be able to pull in more real life experience as well as use inquiry based instruction to help my students see the energy crisis through a new dimension (zero G)*
>
> *I now have a way to bring the space/aeronautics piece into my classroom and make it relevant through our flight week experience*
>
> *I use so many STEM topics already, but have never been able to tie space/aeronautics into my curriculum. Now I can!*

Below are some of the specific topics teachers listed for integration of RGO:

Gravity	Fluids (motion, mechanics, diffusion)
Scientific inquiry, experimental design	Class labs (transformation)
Chemistry (reaction rates)	Data analysis (stat class)
Space unit	Biofuels (mechanics)
Electro chemistry principles	Electro chemistry principles
Electrochemical cells	Electrochemical cells
Gases and kinetics unit	Gases and kinetics unit
Measures of central tendency	Plasma, DNA
Physics of rotational motion	Problem solving physics
Quadratics	Use of remote sensing technologies
Volume of masses	Use of remote sensing technologies

In response to this question, NES teachers gave these examples:

- *Periodic Table of Elements, gases, density, gravity, etc.* Excellent tool for talking about elements and understanding symbols and numbers.
- *Scientific method is included every year in our curriculum frameworks. Our ninth graders who were most involved take physical science and all of the gravity, and physics involved fit exactly. The mathematics connected to our AP math curriculum as well as the student impact surveys.*

- *We chose the experiment based on state standards, I also teach gifted students so all activities and events, and experiments met national Gifted Goals and Standards*

Education standards that could be addressed include the ones in the following table, taken from the lessons on microgravity provided to NES teachers. It would be beneficial to have other standards identified so teachers see how RGO fits their curricula.

National Science Education Standards (NSES) Physical Science (5-8) Motions and Forces 2.2 An object that is not being subjected to a force will continue to move at a constant speed and in a straight line 2.3 If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

American Association for the Advancement of Science (AAAS) Benchmarks for Science Literacy <u>The Physical Setting, Motion</u> Grades 3-5, #1 Changes in speed or direction of motion are caused by forces. The greater the force is, the greater the change in motion will be. The more massive an object is, the less effect a given force will have. Grades 6-8, #3 An unbalanced force acting on an object changes its speed or direction of motion, or both. Common Themes A: <u>Systems</u> (3-5) In something that consists of many parts, the parts usually influence one another. Something may not work as well (or at all) if a part of it is missing, broken, worn out, mismatched, or misconnected. A. Systems (6-8) Thinking about things as systems means looking for how every part relates to others. The output from one part of a system (which can include material, energy, or information) can become the input to other parts. Such feedback can serve to control what goes on in the system as a whole. Any system is usually connected to other systems, both internally and externally. Thus a system may be thought of as containing subsystems and as being a subsystem of a larger system.

On a scale of 1-10, how much do you think you benefitted from this experience?
There were no ratings lower than seven and 89% rated it nine or ten from the TFS NSTA teachers. Teachers most often commented on how they would be able to bring back an exciting scientific experience to share with their students and that they can teach some concepts better through the NASA experience.

Rating	# Responses	% Responses
7	2	5%
8	2	5%
9	5	13%
10	29	76%

Sample Comments

- *Almost forgot how exciting the problem solving aspect of science is*
- *Only because I reserve 10 for the spiritual stuff*
- *Once in a lifetime opportunity to share with students*
- *Amazing experience of NASA and science*
- *I will be able to explain physical science concepts better*
- *I absorbed technical info and enthusiasm like a sponge*
- *I've seen this before but it was better to actually participate*

- *I have learned about myself and have gotten new materials to use in my classroom*
- *10+ this has been the best experience. Being able to tell my students about weightlessness will be wonderful*
- This was the most informative and enjoyable experience in 20 years of teaching.
- *Loved every minute we were here. Great presentations for prevention of motion sickness.*
- *We had an amazing week! Thank you so much for piloting this program. We have learned so much from our research, each other, and NASA. I am eager to begin sharing all we have learned with our students and community!*
- *We will be using the info/experience in the classroom this coming year. There was simply not enough lead time to get students/classrooms really involved. It takes time to integrate new concepts/experiences into the curriculum. I fully intend to use my new knowledge in the coming school year.*
- *This has been the single most amazing experience of my professional life. I would do it again in a second.*

Will you submit an **application next year**? This is an interesting finding. After a terrific experience, most teachers report they will not re-apply. This suggests that there may be at least two different target populations – those who can't get enough and will build on what they have done, and those who wanted to do it once but one was enough. This strengthens the idea of options, allowing people to be involved as much or as little as fits their interest level, time and needs.

	# Responses	% Responses
Yes	7	26%
No	16	62%
Maybe	3	12%

Sample Comments

- *Definitely, already thinking!*
- *Oh yeah. I'll get started early!!*
- *We hope to reapply to further our study of carbon emissions in Zero G*

The **NES Evaluation Results from 2004-2010** were retrieved and summarized across years. The flights in 2005 were postponed due to aircraft issues.

In every area over the years, the NES teachers rated the RGO experience as valuable, inspiring, and relevant to their roles in education. They expect to apply what they learned and can connect the content to their curriculum standards. They would recommend the program to other teachers and think this is a good use of NASA resources. As one teacher wrote:

> *The experience has motivated me to a higher level. I want my students to reach higher now. I want to provide them with new experiences, show them what's out there... things, careers that they would otherwise know nothing about. I am a better teacher after having participated in this program. Not only that, but by*

inviting other teachers to join me, it has opened up their eyes as to what the program is all about. They are reaching outward to others now.

Please rate each statement 1-5=highest	2004	2005	2006	2007	2008	2009	2010
N=	17		30	70	48	40	45
Participation in the program was a good investment of my time	5.0		4.8	4.9	4.9		
The program was a valuable experience.	5.0		4.9	4.9	4.9		
The program was inspiring	4.8		4.8	4.9	4.8		3.8
I would recommend the program to someone else.	5.0		4.9		4.9		
I acquired the skills and/or knowledge offered to participants.	4.8		4.6	5.0	4.8		
Overall rating of the program.	4.7		4.9	4.9			
The information provided in the Program is relevant to my role in education.			4.5	4.9	4.8		
Offering the Program to educators is a good use of NASA resources (i.e. facilities, engineers and scientists, etc.)			4.8	5.0	5.0		
I expect to apply what I learned			4.5	4.9		4.7	4.3
My participation has met the expectations of my school			4.5		4.7		
I plan to use these materials in my classroom (2009 Inspired to bring NASA content into classroom)			3.6			4.8	4.6
I have a better understanding of NASA's support for education				4.9			
I learned more about careers related to NASA				4.9	4.8		
NASA related materials provided can be integrated in your curriculum (2009 align well with what I teach)				4.8	4.7	4.3	4.8
The program is easily integrated into state and national standards				4.8	4.6	4.7	
My participation in the program has met the expectations of my school/district.				4.9			
This experience matched my educational objectives.				4.8	4.7		

On a scale of 1-5, teachers reported strong **effects on their teaching** (4.6), integration and application of STEM G topics (4.8-4.9) and career education (4.9), instructional technology for students (4.5-4.6) and teachers (4.5-4.6), inspiring and encouraging student exploration (4.7-5.0) and increasing family involvement (4.1-4.8). Missing data indicates the question was not asked that year.

Please rate how this program impacts your classroom.	2004	2005	2006	2007	2008	2009	2010
N=	17	0	30	70	48	40	45
Based on my NASA experience, I will make changes to my teaching activities.						4.6	4.6

Integration of career education in STEM-G				4.9	4.9		
The application of STEM G.				4.8	4.9		
Instructional technology for students.				4.6	4.6		
Instructional technology for teachers.				4.6	4.5		
Inspiring my students (2009 increasing interest; encouraging student exploration)			4.6	5.0	4.9	4.7, 4.9	4.7
Increasing Family involvement.				4.5	4.1		4.8

When asked what they accomplished, most teachers reported new concepts, insights or discoveries (73-81%) and student experiments (83%). Missing data indicates the question was not asked that year.

Accomplishment		2004	2005	2006	2007	2008	2009	2010
	N=	17	0	30	70	48	40	45
Hardware product					43%	40%		
New concept/insight/discovery					73%	74%	81%	
New process or technique (2010 subject matter)					37%	50%	30%	
Software product					13%	9%	93%	
Curriculum Integration Wheel					28%			
Student Experiment					83%			
Other (2010 print materials)					12%		58%	

There are several remarkable stories from K-12 teachers. A teacher of incarcerated youth reported that it completely turned around a lot of his students. They were so excited to be part of something so amazing, they became more interested in studying and particularly science, finishing their GEDs. Another teacher's own ninth grader was so inspired by his mom's RGO experience he turned around his grades, went to a good university, and became an engineer.

Summary of Evaluation Findings

Evaluation data on RGO has included attendance and participation data (the number of teams that are accepted and follow through), survey data (primarily standard questions from NEEIS, and now OEPM), and completion of requirements (forms, procedures, reports). Videos and final reports are reviewed for whether or not they met the requirements of what was to be included more than their quality. Getting information on the follow up teachers do has been challenging and is important to evaluating the effect of the program on audiences beyond the teacher and student teams. The evidence we currently have on their follow up comes from their plans for follow up that are approved as part of the application, and their survey responses that indicate a lot of excitement and intention to follow up. The TFS NSTA approach of having ongoing contact, support and offering them a national platform for presentation has potential for collecting these data as evidence of effects, and also reaching a wider audience. They need to have a format that includes data on who has been involved beyond the teacher and student team, and how they have been involved.

IV. Options for Future Programming

The key questions for this evaluation were to examine what has been done in K-12 with RGO toward identifying:

- The appropriate target population
- How to promote the program and increase the number of applications (thereby increasing the quality)
- The timeline for the experience
- The nature of the experience (total inquiry, replication, pre-defined experiments, demonstrations)
- The support teachers need and want throughout the experience
- The flight week length and activities
- How to ensure and find out about follow up activities beyond the teacher and student team
- The effects on students, teachers and their community

This chapter is organized around these issues. Suggestions are presented in each area based on the findings in Chapter III.

The Appropriate Target Population

Given what we know about what makes teachers successful in RGO, the key is to weave these into the entire process. The required characteristics can be reflected in the name of the program, the goals and objectives (for each option), the description of the program, the application description of each team member, in the TRR where each person can introduce themselves and their role, in the follow up log, and in the final report and presentation. If additional program options are offered (such as replication, pre-defined experiments or demonstrations) each option would have its own goals and objectives to reflect the differences. This is discussed more in the section on applications.

Teacher characteristics?

The ideal teacher candidate for the inquiry model of RGO is a highly motivated, hard-working leader in his or her schools who has a flexible approach to curricula, knows how to involve students and values the inquiry approach. He or she is knowledgeable about microgravity and experimental methods. These characteristics were identified by former participants, staff, and through our observations of the teams at work. Teachers who have these characteristics are not bothered by the requirements because they have the interest, skills and attitude to participate. They need to ask clarifying questions but will probably not require reminders about deadlines, responsibilities or requirements. They are excited to participate and understand that it is an extraordinary opportunity that contributes to learning and teaching in their community.

Elementary, middle, or high school teachers?

Teachers from all three levels report great benefits for their students. Elementary teachers emphasize the motivational value and getting young students excited so they develop their content knowledge of STEM. Middle school teachers also report that RGO is very motivating to students, and that it helps them teach difficult motion and forces concepts in their curriculum. Both these levels emphasize the flexibility they have in their curricula to use this NASA experience as a context for learning. High school teachers report that this is a wonderful career-related experience in which their students see how what they are learning in the classroom applies to the real world of work. They experience the richness and complexity of doing real research, while they learn and apply complex concepts to the design, building, testing and results phases.

In the findings section we explored how the RGO goals and objectives need to be written to support what successful teachers tell us they can do with RGO. Draft goals were written to illustrate how the program requirements would differ for each grade level band:

Elementary Goals

- Teachers use RGO to engage students, faculty and the community to motivate them to learn more about NASA STEM topics, processes and careers.
- Students learn what it is like to be a researcher by participating in a reduced gravity experiment.

Middle School Goals

- Teachers use RGO to enhance their curriculum by engaging students in a microgravity experiment.
- Students are motivated to learn more about NASA STEM topics, processes and careers related to gravity.
- Teachers and students share their experience with their school and community to motivate to others to learn more about NASA and STEM.

High School Goals

- Students and teachers experience an immersive inquiry learning experience using NASA unique content and resources about gravity
- Teachers are prepared with knowledge and NASA resources to support students in doing inquiry about gravity through designing and conducting an experiment in hyper and microgravity
- Students and teachers share their inquiry experience and results with their school, families and community to motivate to others to learn more about NASA and STEM.

Subjects?

RGO currently recommends that at least one person on the team have a strong physical science background. This ensures a local resource through all the phases of the program and someone who can work effectively with the NASA mentor. Often this person is the team lead. Other team members can make significant contributions from their own disciplines, but they need to think it is a valuable contribution to their curriculum and integrate it into what they teach. Each team member needs to have a significant and well-defined role from the application through follow up.

How To Promote The Program

A multi-pronged approach is needed to increase awareness about RGO for K-12 teachers. Options are described based on the findings in this evaluation. Teachers who show interest, apply and follow through should all be asked how they found out about the program to determine the effectiveness of each approach going forward. NSTA has a lot of experience promoting competitions and managing programs so they could be asked to extend their efforts, or TFS could do promotion within NASA as part of their other outreach efforts. RGO advertises the Undergraduate program promotion so they could also be involved.

Mailings

In this next year, the program probably needs to be heavily promoted with detailed information about goals and objectives, requirements, timelines, benefits and link to a website with even more information. Teachers told us they did not know about it, even those who were looking for it. Emails could be sent through other NASA programs to their participants. Other STEM programs for teacher, (not NASA related) could be approached to share this opportunity with their members, such as NSF and NOAA funded projects. NSTA could send it to their membership. These groups often have highly motivated teachers involving their students in research. Similar to the undergraduate program, a trifold print brochure could be sent to science supervisors and/or directors of curriculum in the 15,000 districts in the country, with a request to pass on the information to specific teachers who they think would benefit. With more promotion this year, this may not be needed in future years. The number and quality of the applications will be the indicator. NSTA could be contracted to promote the program, or TFS could do promotion within NASA's programs as part of their other outreach efforts.

Web Presence

A search for microgravity yields the undergraduate RGO site at the top of the list. This website could feature a prominent link that takes K-12 teachers to information about the goals and objectives, timeline, requirements, application and sample projects such as on the private work space created for this report (http://rgotfs.pbworks.com). Teachers told us they need and want to see the all the information up front so they can decide whether to apply, know who to recruit for team members and plan their time.

Create Buzz

Publicize the program through articles in science magazines, presentations at conferences and the website. Have NASA feature it on their home education page. Pay an outstanding RGO teacher to do a NASA blog or a private one that interviews other teachers and students, features a different experiment every week and gets people excited. Make a place on the website for teachers to upload their abstracts, pictures and press so everyone can see them. Create a discussion space or group page on Facebook that everyone can link to.

Make Year after Year Opportunities Available

This will promote institutional interest and develop experienced teachers who are familiar with the process and can mentor new teachers and students through it. Developing a mentor core, or even an expectation, would also create a resource for the program for ongoing promotion. They could be sent to conferences to do presentations, mentor new teams, answer questions from potential applicants, and recruit in their region through science meetings, newsletters and events.

<u>The Number of Applications</u>

With clearly defined target audiences and goals and objectives for each option, the program can be widely advertised to get the best possible pool of applicants. Teachers told us it needs to be very clearly stated that it is a competitive process and that their proposal may not be chosen. If there are options that require less up front work with their students, those who are not comfortable with possibly not being accepted might choose these less involved options. Those who are used to doing competitions with their students will be comfortable because they know the students will get a lot out of the preparation experience and that not being selected can be a good life experience. Runners up in the selection could have their experiments flown by staff, other team members, or teacher mentors.

Teachers and staff thought the application for TFS NSTA RGO was adequate to review the team's proposal. It is recommended that the goals and objectives be part of the application, so applicants address exactly how they will meet the objectives. More description of what goes in each section would also help applicants provide what is needed for review. Examples of good applications could also be provided on the website, along with abstracts of projects for ideas. Peer mentors could be offered for help in developing the application. The webinar providing the overview was perceived as helpful so it should be continued and perhaps be offered more than once. A list of relevant experiences that they check off and then describe would help identify those with experience with inquiry, competitions and long-term projects.

If multiple options are offered such as using prebuilt apparatus, predefined experiments, demonstrations or having an experiment flown by RGO staff, the application needs to reflect the specific goals and objectives, requirements, and timelines for each option. If some options are pre-requisite to the inquiry RGO, that needs to be clearly stated.

<u>The Timeline For The Experience</u>

From examining the timelines from the pilot, NES and the undergraduate programs, and asking the participants and staff, it seems that a timeline of 10-12 months is required for the current version of the program. The deciding factor is when the flight week is held. If a full flight week is continued, some teachers are unwilling or unable to commit to that during the school year. They would prefer to do it during the summer when they are not teaching. Other teachers like making RGO a yearlong project that culminates with presentations at the end of the year. They prefer a flight in early April on the project they started the year off with. Given the timing of this evaluation, it will not be possible to advertise this year for an October deadline, so perhaps continuing with the January to December timeline is best for next year.

If other options are offered they would require less time for both preparation and flight week so could be offered during the year.

The Nature Of The Experience

The current K-12 experience (both NES and TFS NSTA) are based on the original undergraduate experience in which students write technical proposals to apply, then build their apparatus, fly their experiments, analyze the results, and present their findings in a final report and outreach presentations. The emphasis is on immersing the students in a career-related experience. The SEED program is also for undergraduate students but they work with a NASA Principal Investigator to design an experiment that they fly. SEED is also a faculty development program so the faculty advisor from the university is invited to come to Houston and fly with the students. In SEED the students do not come up with the research question, but they still design, build, test, analyze results and report findings in a final report and a presentation.

For NES, the application was modified to provide some additional guidance for writing up the experiment and a NASA mentor was assigned to each team to support them in the development of the technical aspects of their experiment. Glove boxes were built to provide one level of containment and so make safety approval easier. Flight week activities were the same as for the undergraduate model. For TFS NSTA the hypobaric chamber and flight physical were dropped, and the flight week shortened by one day. The goals for an inquiry based experience of coming up with a question, developing a design, building, testing, analyzing data, writing up results and making presentations remained the same as the undergraduate experience.

When asked about other options for an RGO experience, some teachers were adamant about the importance of students having the full inquiry experience, from defining the question through presenting their results. Others liked the idea of having pre-built apparatus that they could then develop experiments for because of the difficulty of building strong, precise tools that would work in micro and hyper gravity. Some teachers also liked the idea of doing pre-defined experiments that had already been tested and proven to yield good data, and even comparing their own data to the pre-existing data. Other teachers liked the idea of doing demonstrations that they would then have video of to use in their classrooms to teach difficult concepts. Some also liked the idea of having their experiments flown since it would cut down on the time and cost of travel to Houston. The only clear message we got from teachers was that they like different options. Supporting different options could increase the reach of the project and involve teachers beyond the inquiry-oriented type, and maybe help them develop the confidence, interest and knowledge to do the full inquiry approach. A full description of the options appears on page 26 of this report. Here is a summary of the phases of the research that would be done by the team under each option. Other combinations are also possible, such as providing the apparatus for the replication experiments.

	Inquiry	Apparatus provided	Replication	Flown by crew	Demonstra-tion
Develop the question	√	√		√	
Design the experiment	√	√		√	
Build the apparatus	√		√	√	
Do ground tests (1 g)	√	√	√	√	√
Do flight tests (0 g and 2 g)	√	√	√		√
Analyze results	√	√	√	√	
Present results	√	√	√	√	
Do presentations	√	√	√	√	√

Each program could have a name that identifies the focus. For example: Reduced Gravity Design and Build, Reduced Gravity Design, Reduced Gravity Replication, Reduced Gravity Design, Build and Ground Test, Reduced Gravity Demonstrations.

The Support Teachers Need And Want Throughout The Experience

Mentors are the highly appreciated and valuable to the teachers. They were accessible, helpful and took an interest in the students. The biggest request from teachers was to have all the requirements, deadlines, documents and information in the beginning and all in one place. They found the webinars helpful and would like more that are content oriented rather than logistics. They would like an earlier introduction to the NSTA Learning Center and to better understand how it supports their efforts. If the timelines, documents, archived webinars, and specific microgravity resources are housed in the Learning Center, and there are active discussion boards, it might increase the integration with the RGO office's activities in the eyes of the participants. For them to follow up with their PD plans and presentations, they need to see it as the "go to" place for the project.

The Flight Week

The teachers reported that the flight week activities were valuable. Many would like to see it be Sunday to Sunday. They reported their experiments were 70% or more ready when they arrived so they would need to be 100% ready before the TRR on Monday. Teams that needed more time after the TRR could miss out on one of the flights (which might be a big incentive to be 100% ready when they arrive). With the elimination of the hypobaric chamber, the motion sickness briefing at the NBL could be eliminated since the information is presented by the RGO staff and in the printed materials.

If teams are using prebuilt apparatus or replicating experiments, they would have the same schedule as the inquiry group. Teams doing demonstrations would attend safety and motion sickness briefings, and fly only once.

Follow Up Activities

From the NES reports and the TFS NSTA teacher plans we have seen they are doing some really great follow up involving their schools and communities. The more they involve others from the beginning, the more likely they are to follow up. They could benefit from seeing more examples of other teams' follow up activities. If the website, a private workspace or the Learning Center could host a space for each team to log their activities throughout the process that they all could see, they would develop relationships before they met during flight week, learn from each other, use each other as resources, and see all the ways to involve the school and community. We have described a lot of follow up activities here, but the teams would do a more thorough job with pictures, and even video of their events if it were part of the expectations and facilitated with a website to upload. With the web and social media an increasing part of life and education, teacher sand students are accustomed to sharing in this way. It would provide better documentation on what they are doing than we are able to get in other ways. Having year after year activities will also encourage follow up (as it does with the undergraduates) because failure to follow up and report on your activities would diminish your chances of future participation.

The Effects On Students, Teachers And Their Community

Is it worth it? This is a very sophisticated and expensive program. However it fulfills the "as only NASA can" goal, and the goal of TFS to involve students and teachers in flight activities. Teachers report it has a profound effect on students. Six years of NES data show that teachers say it affects their teaching, inspires them and their students to learn more, and supports their curriculum goals. But many teachers go beyond this to say that it is the most extraordinary experience they have ever had, and they will work to help their students experience the thrill of real research. The difficulty does not seem to be that it does not have sufficient effect to justify the cost, but rather that the methods to collect that information have not been applied effectively.

Conclusion

The TFS NSTA pilot has developed and tested some important tools for improving the K-12 approach to RGO. The application with requirements for principal support and a commitment to follow up and reporting are proven strategies in teacher professional development. NASA mentors and webinars were effective forms of support for the teachers. The PD plan in the NSTA Learning Center gives teachers a tool for reporting on their activities and the webinars provide a national audience for the results of their experiments.

To improve the program, goals and objectives need to be identified, and the promotion, application, requirements, activities and evaluation aligned with them. Options for other forms of the program could lead to involving additional participants in different ways. Promotion efforts need to be broad and immediate for a March 2011 acceptance for the inquiry experience. A detailed announcement and full information about the project should result in more quality applications by teachers that will follow through. To communicate clearly about the program, perhaps the name could be refined to Reduced Gravity Research Experience to emphasize that engaging teachers and students in research is the main goal.

Appendix A has been removed from this document as it contains Personally Identifiable Information (PII).